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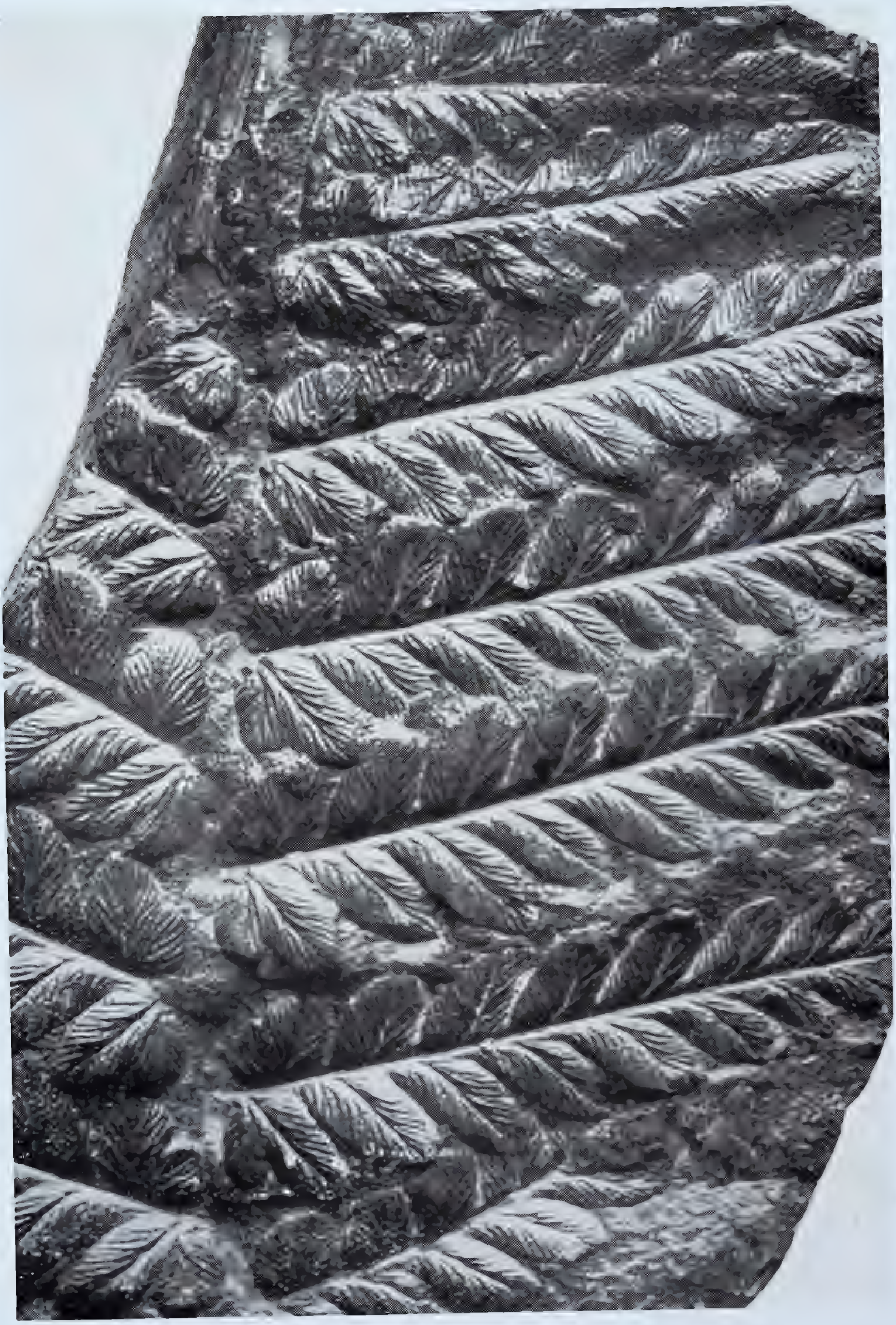

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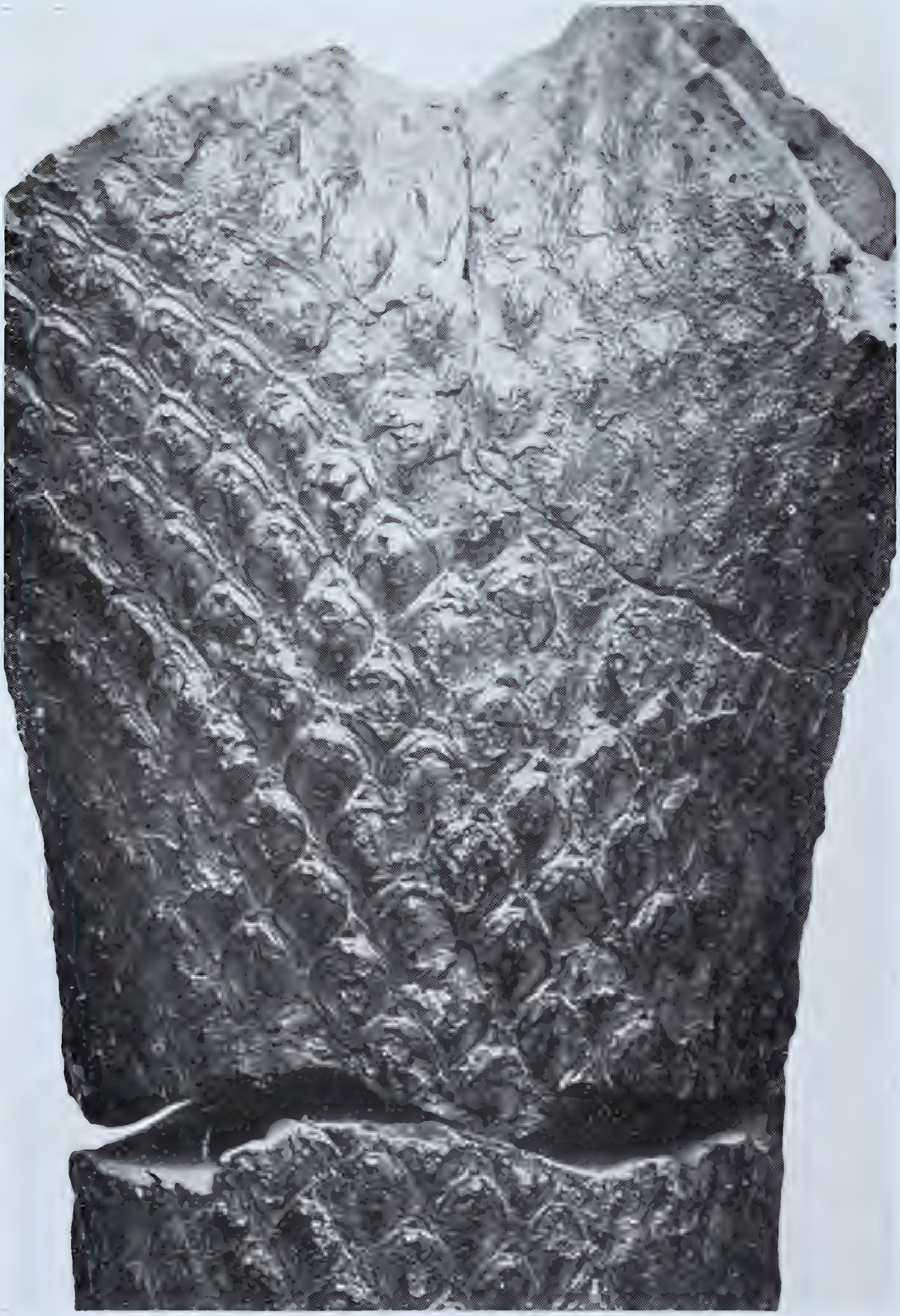

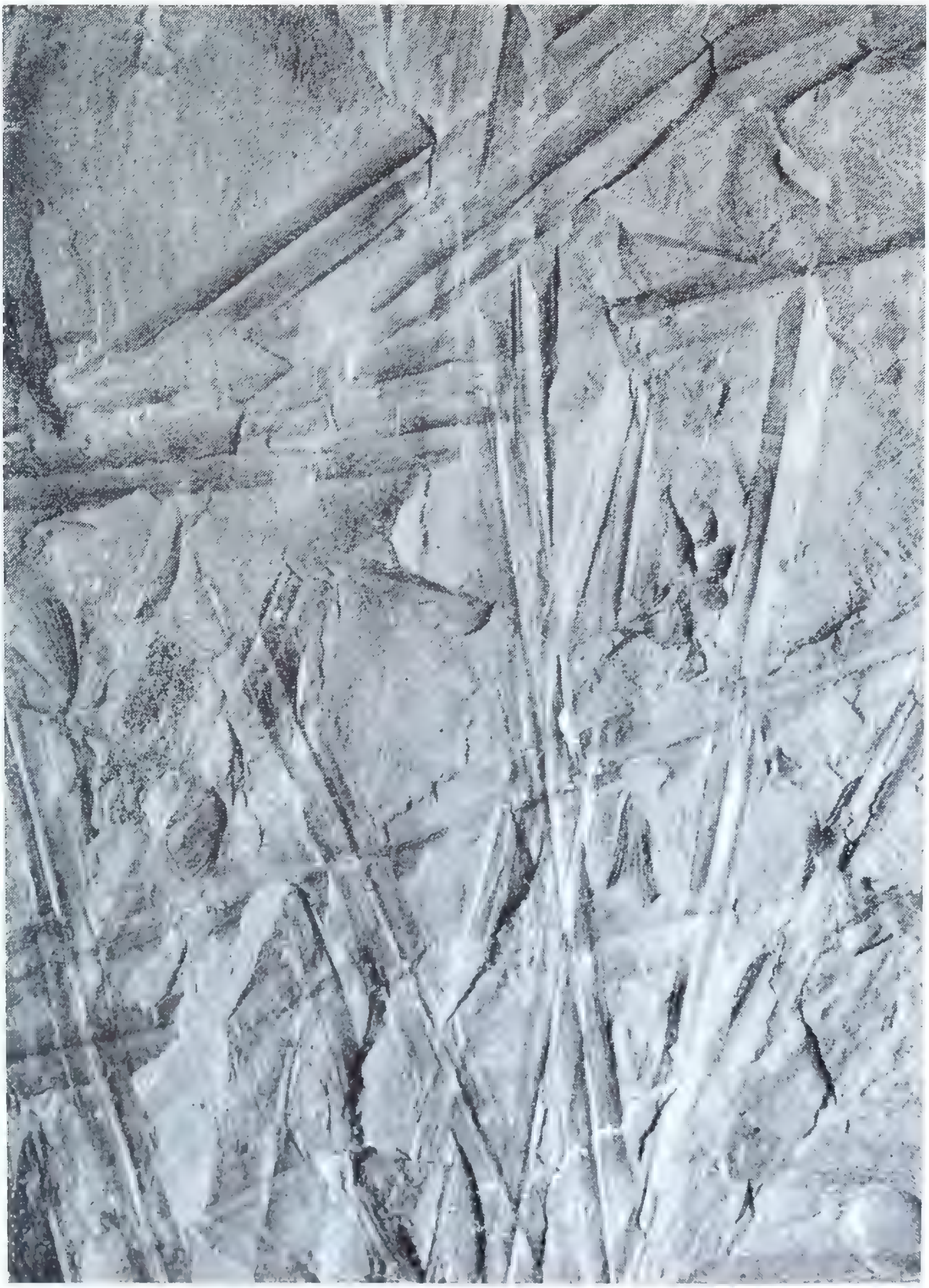

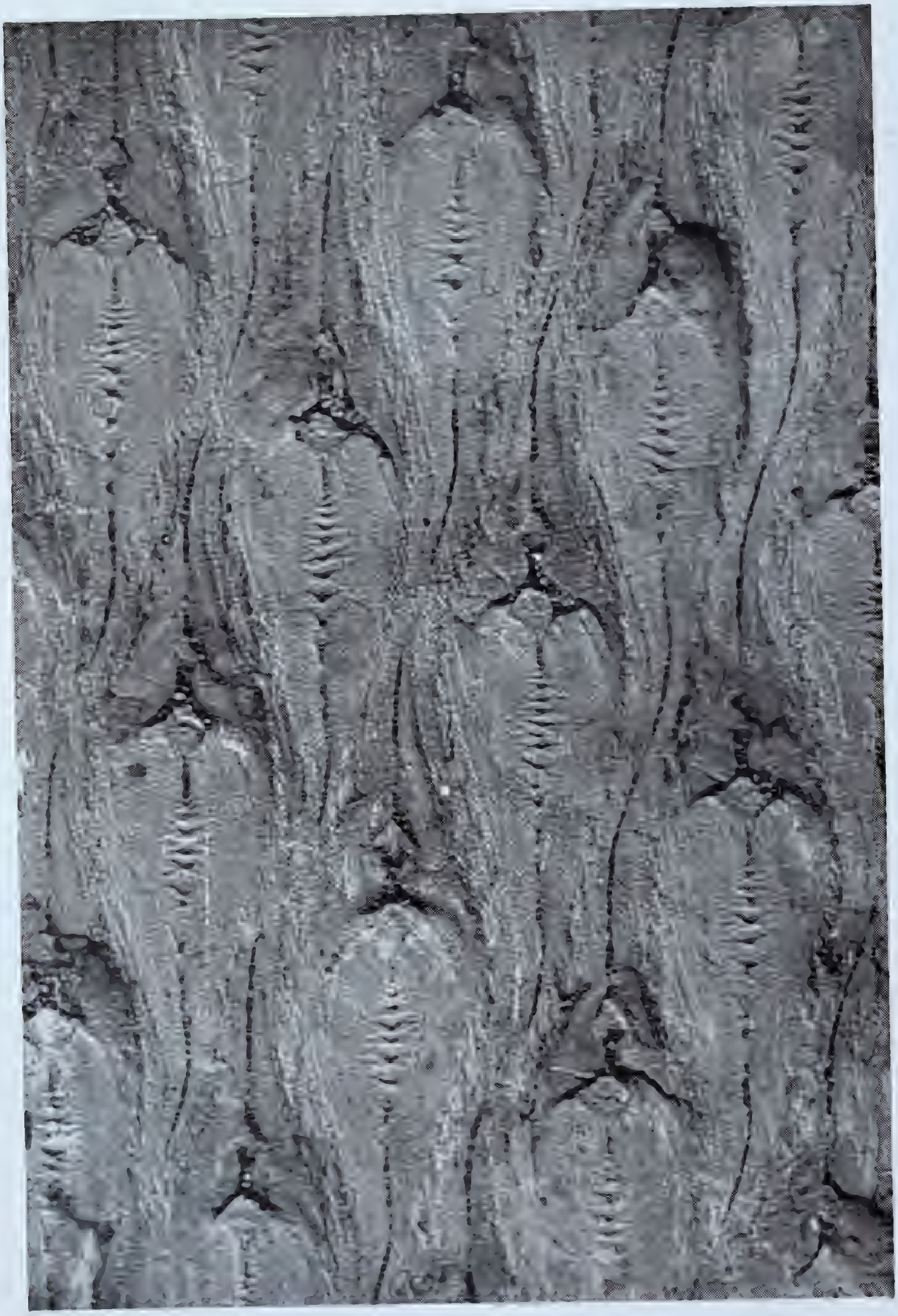

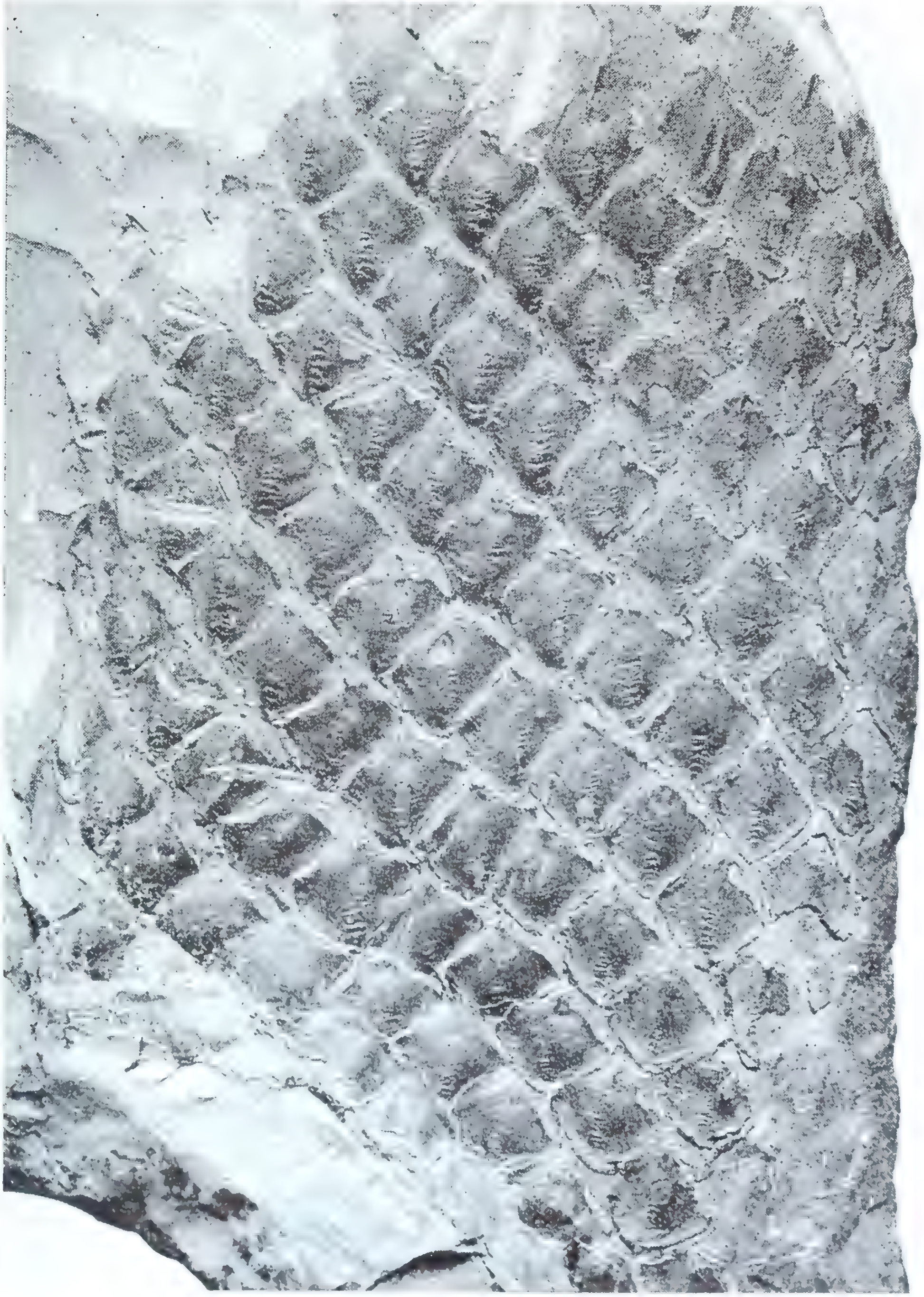

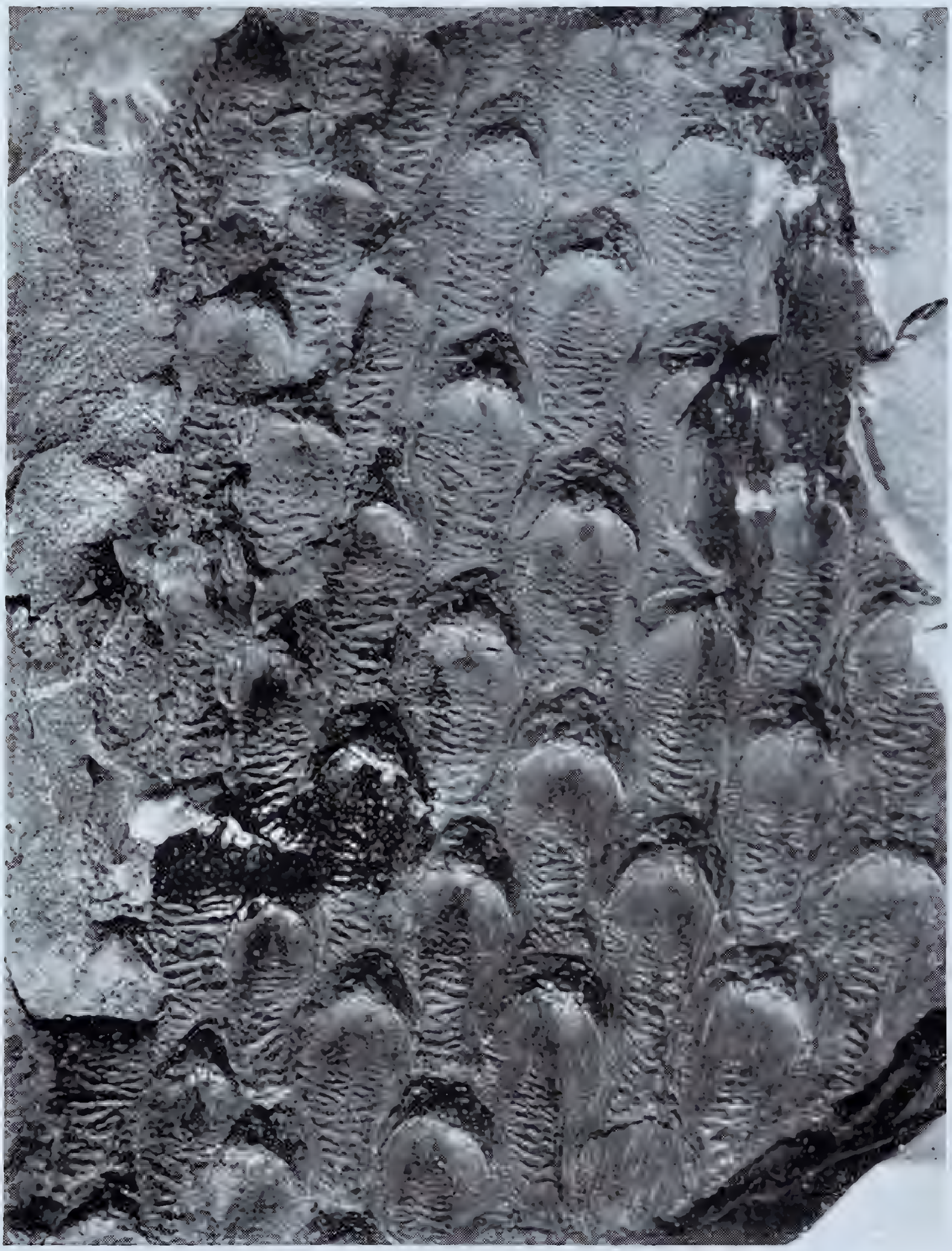

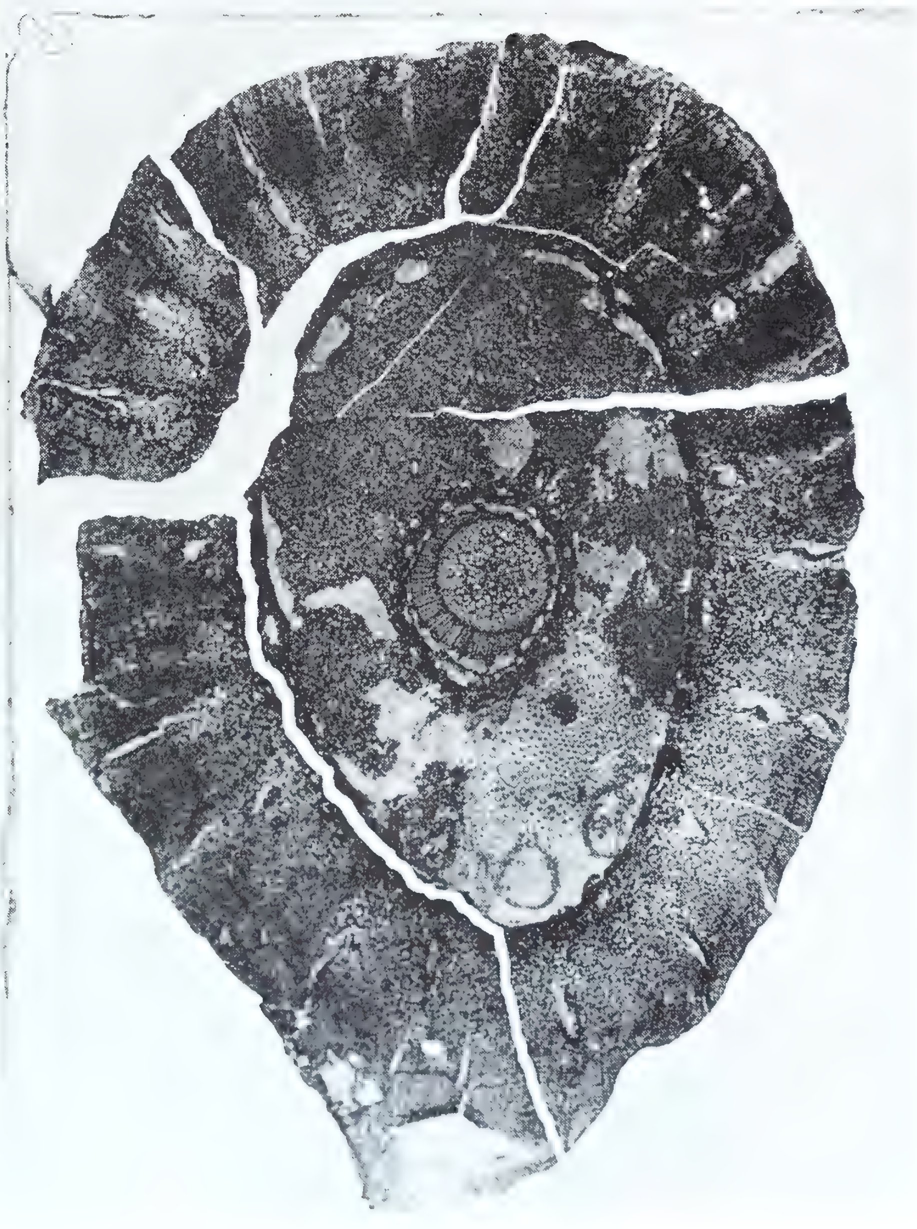

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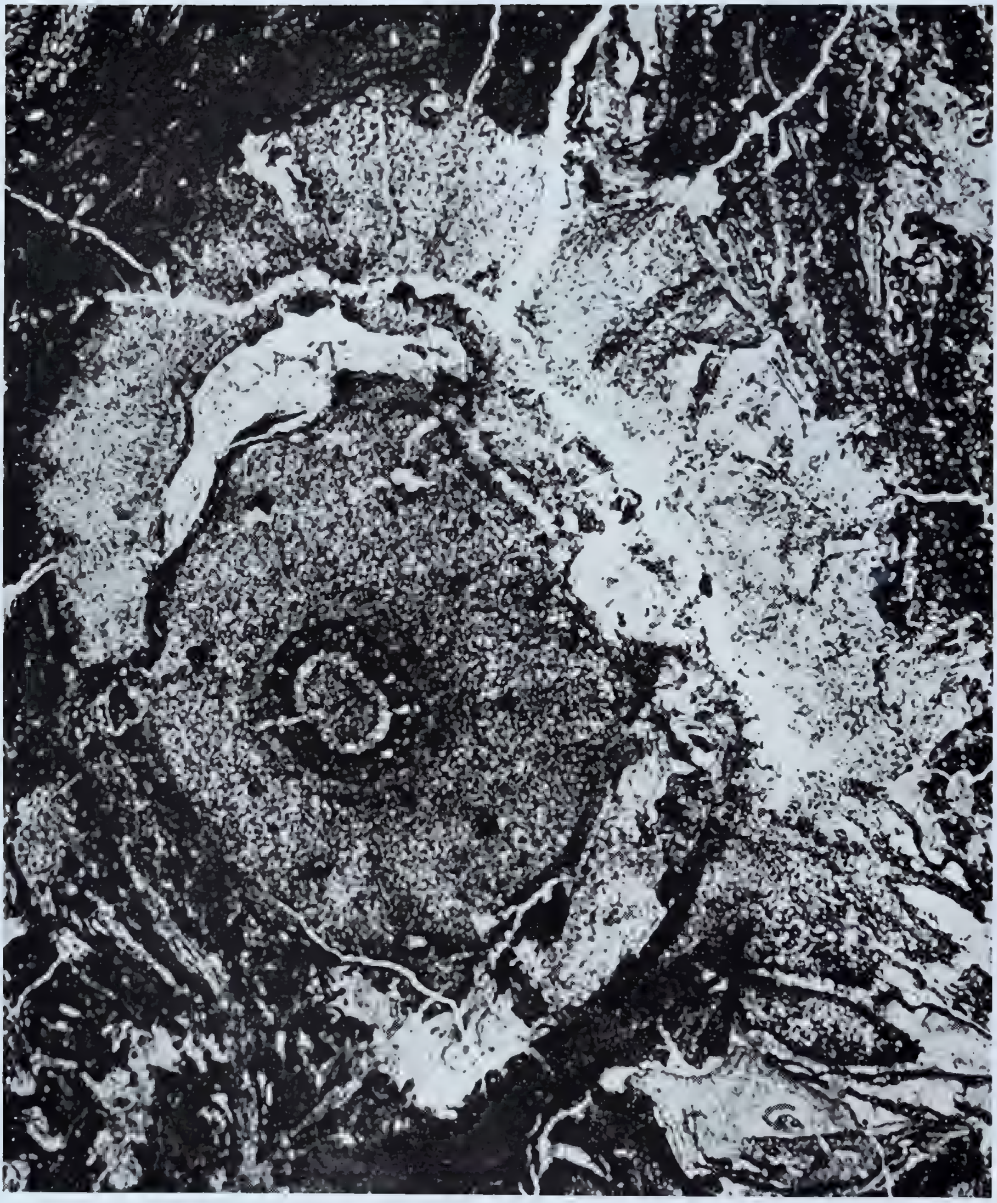

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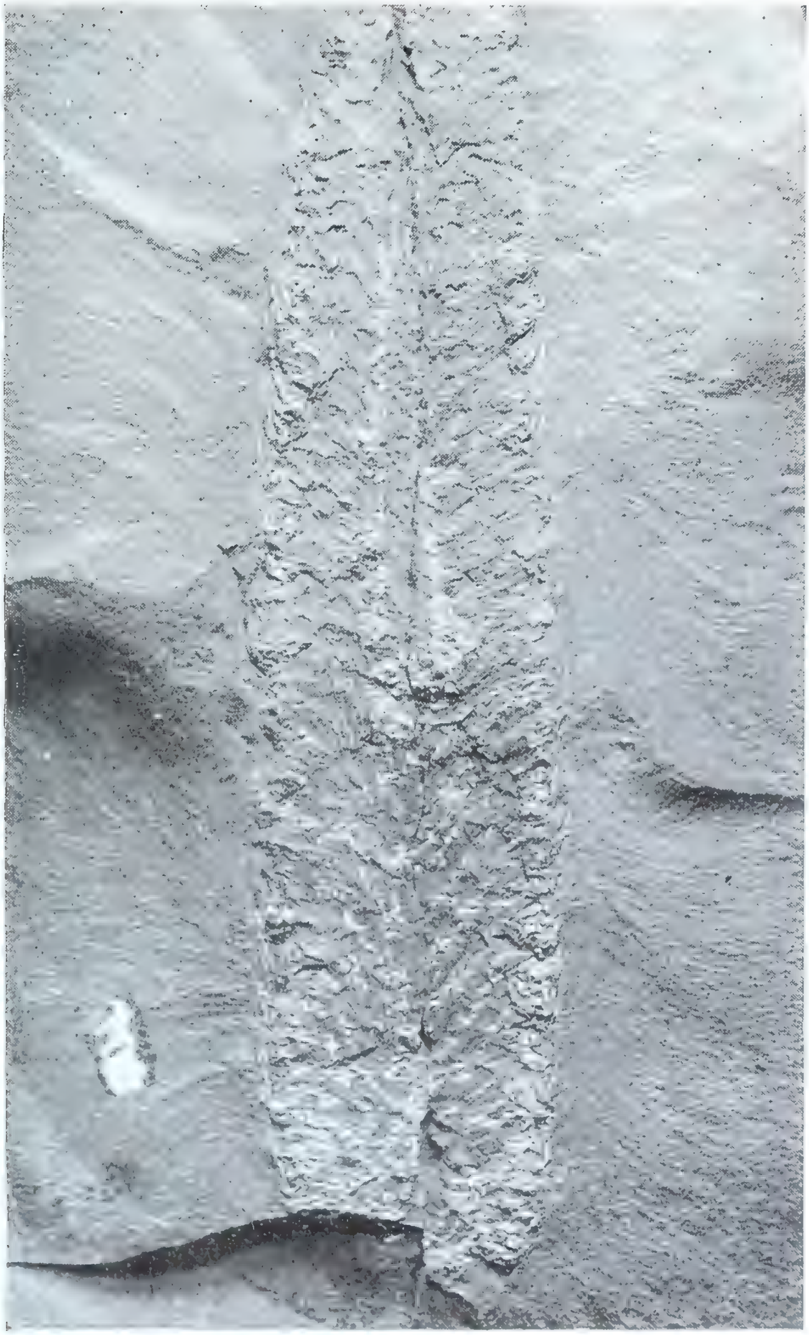

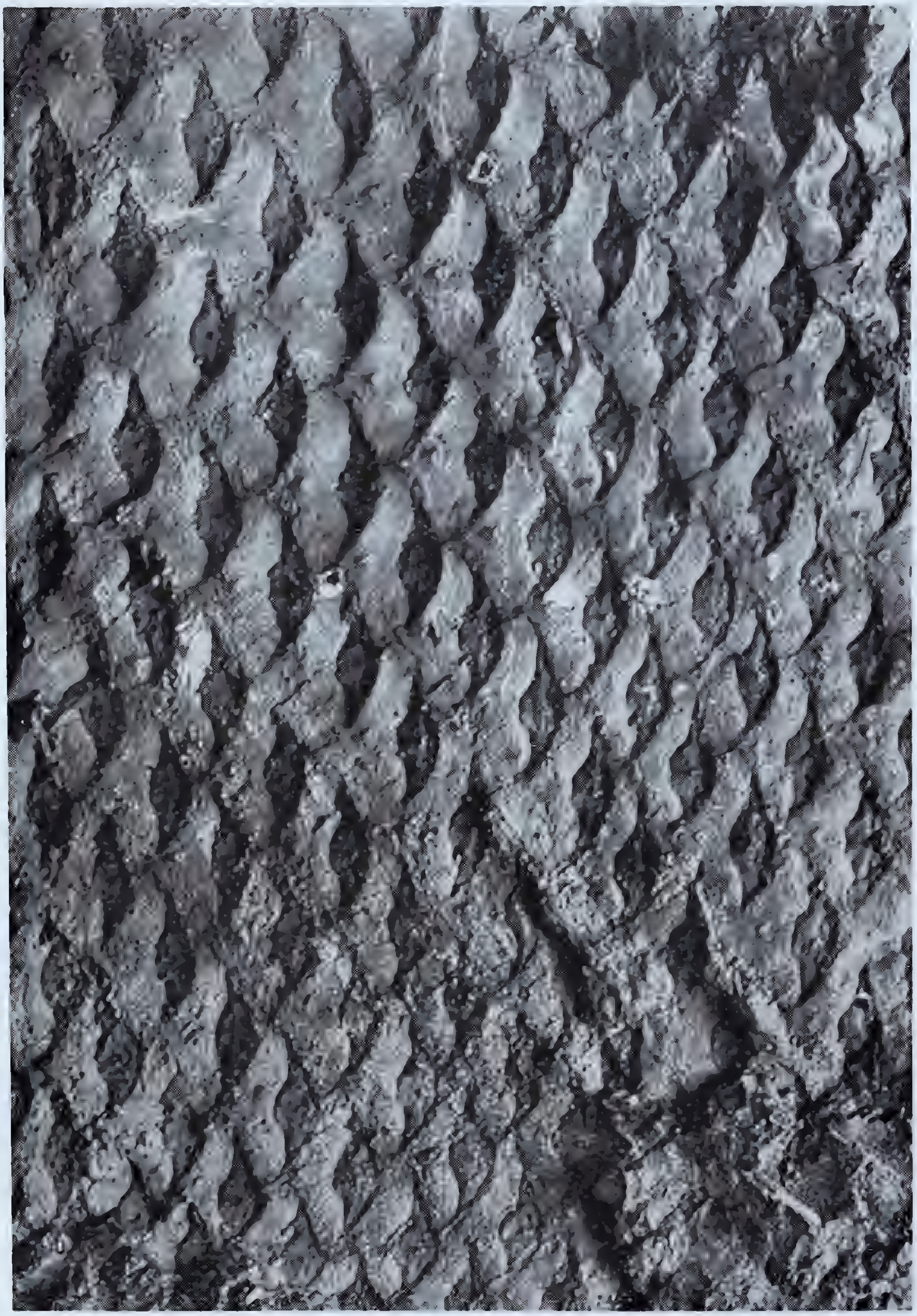

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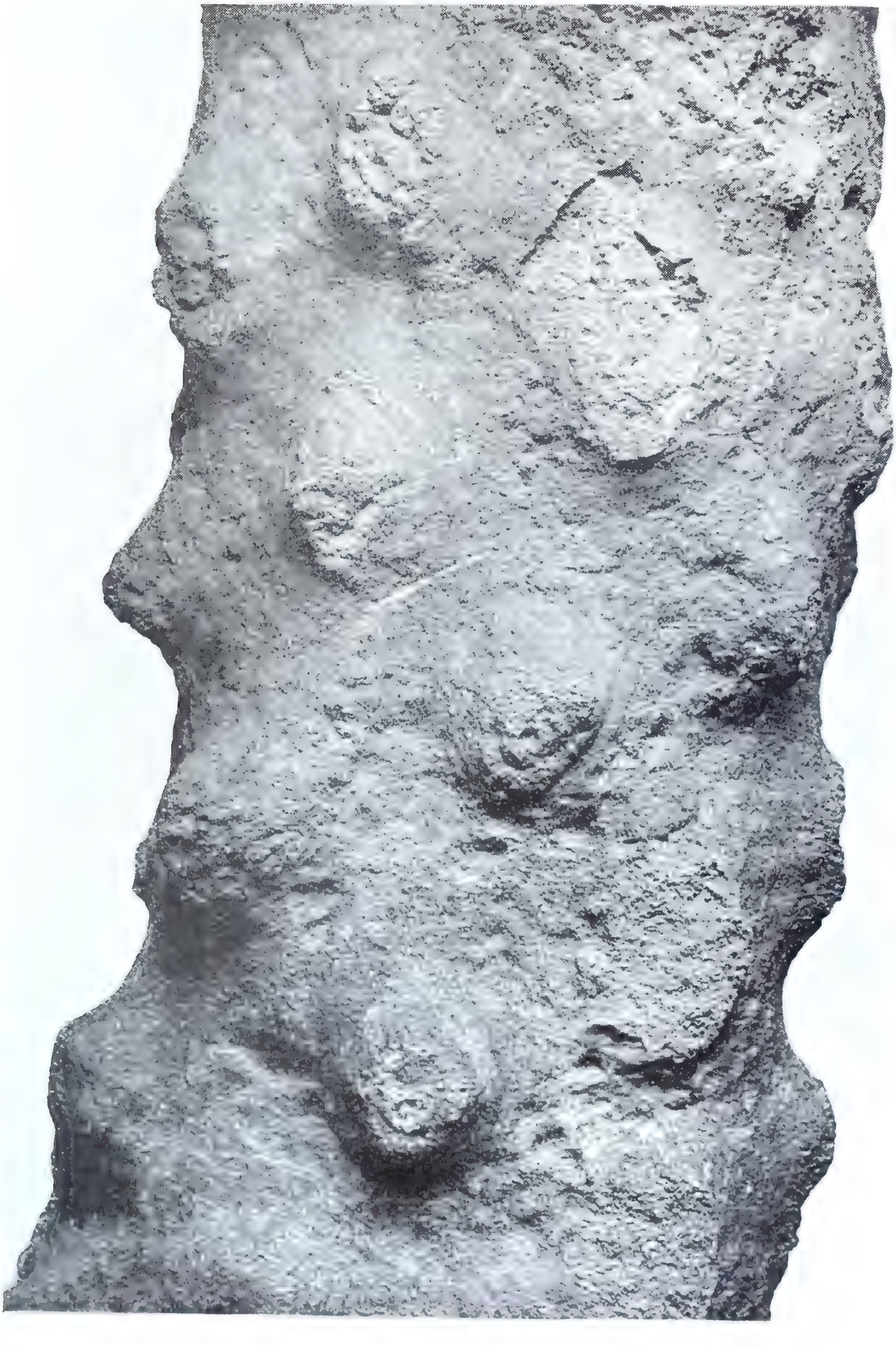

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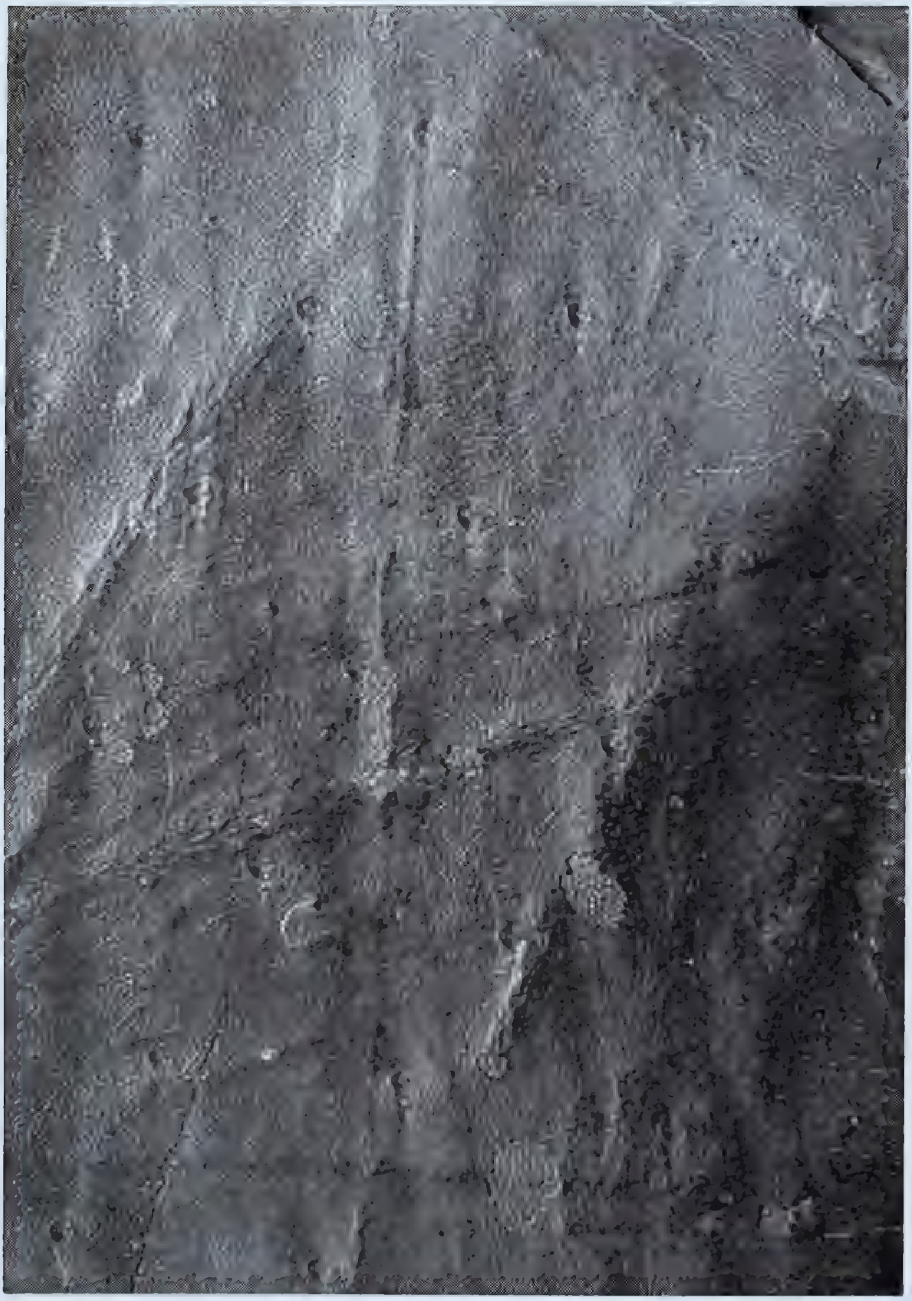

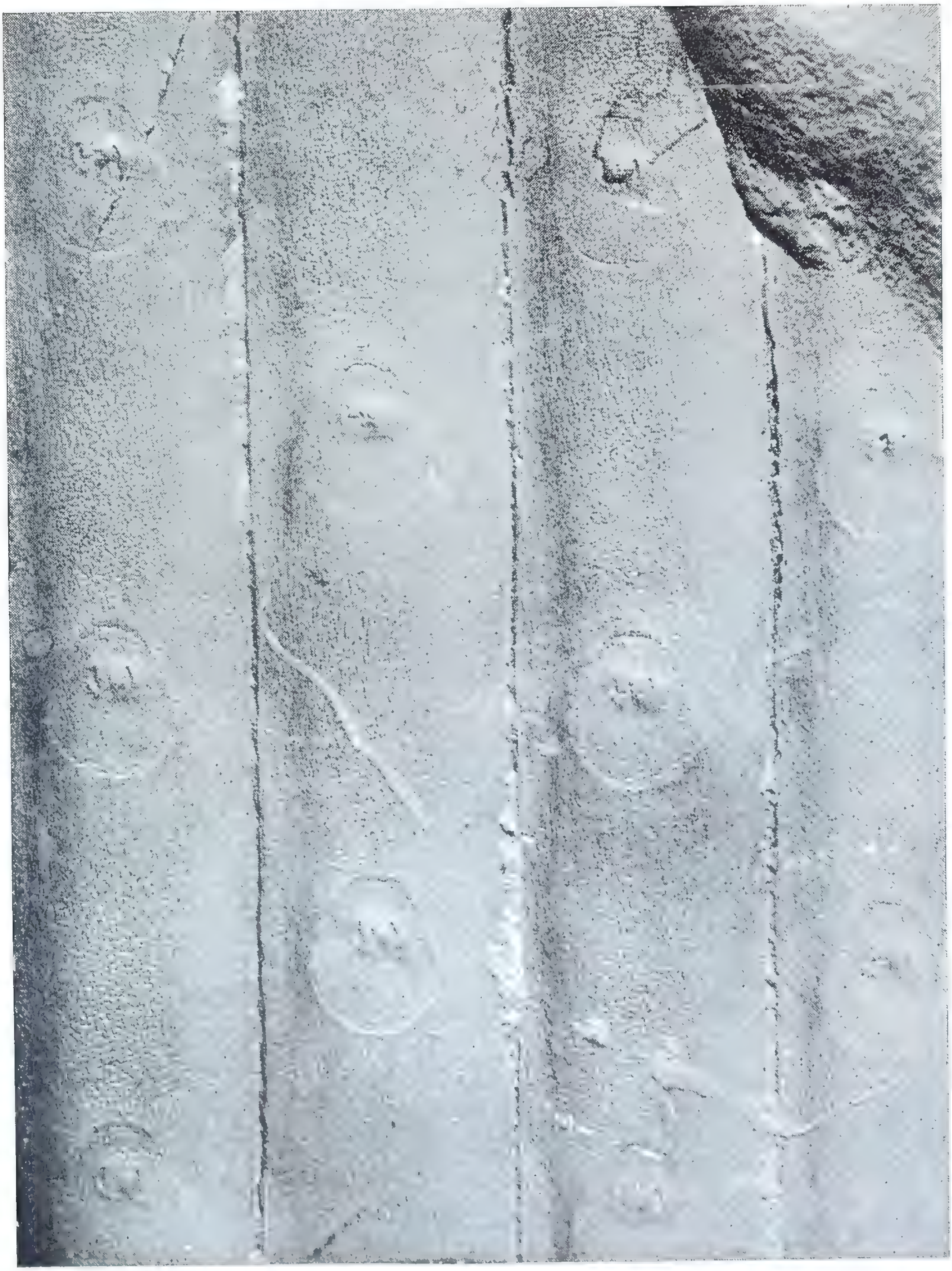

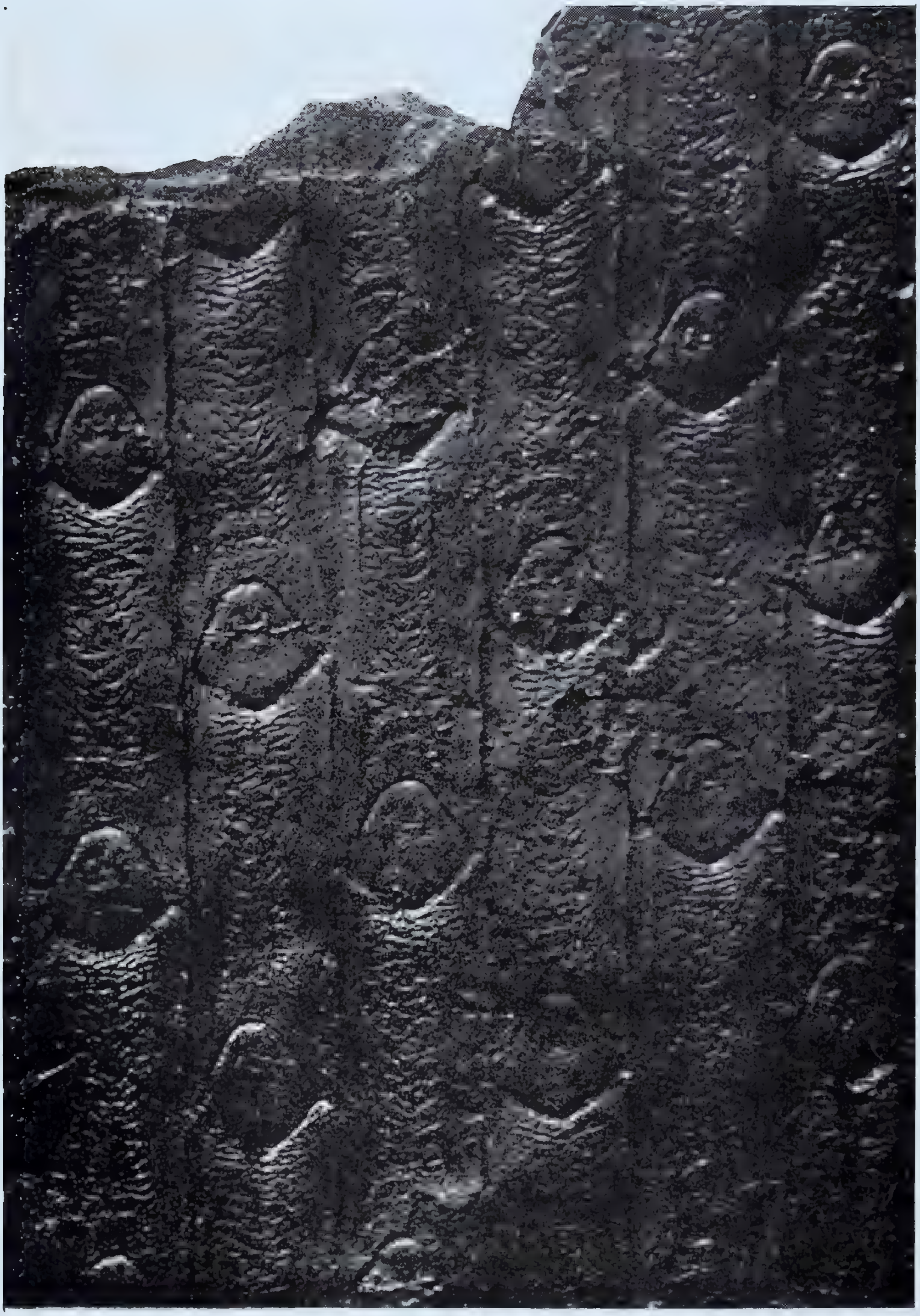

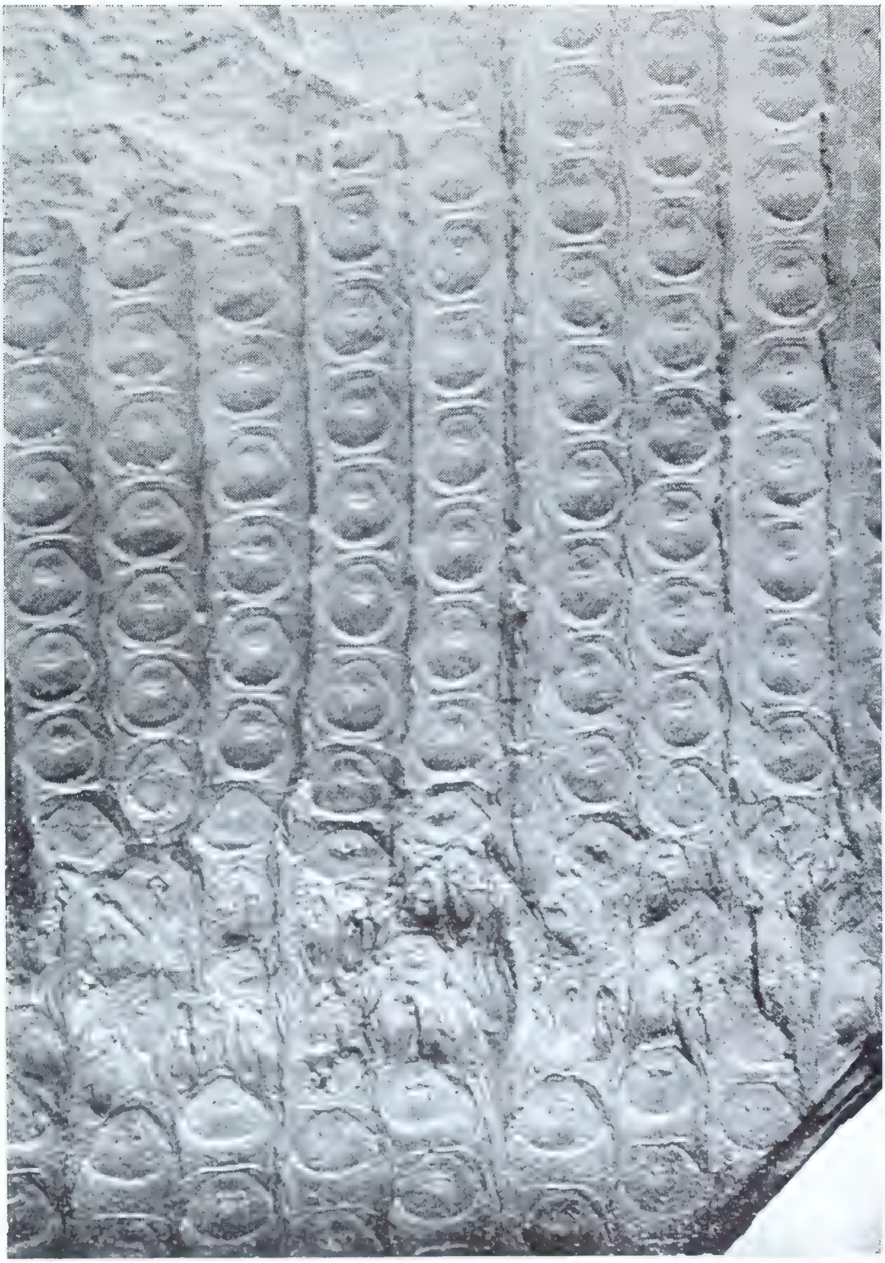

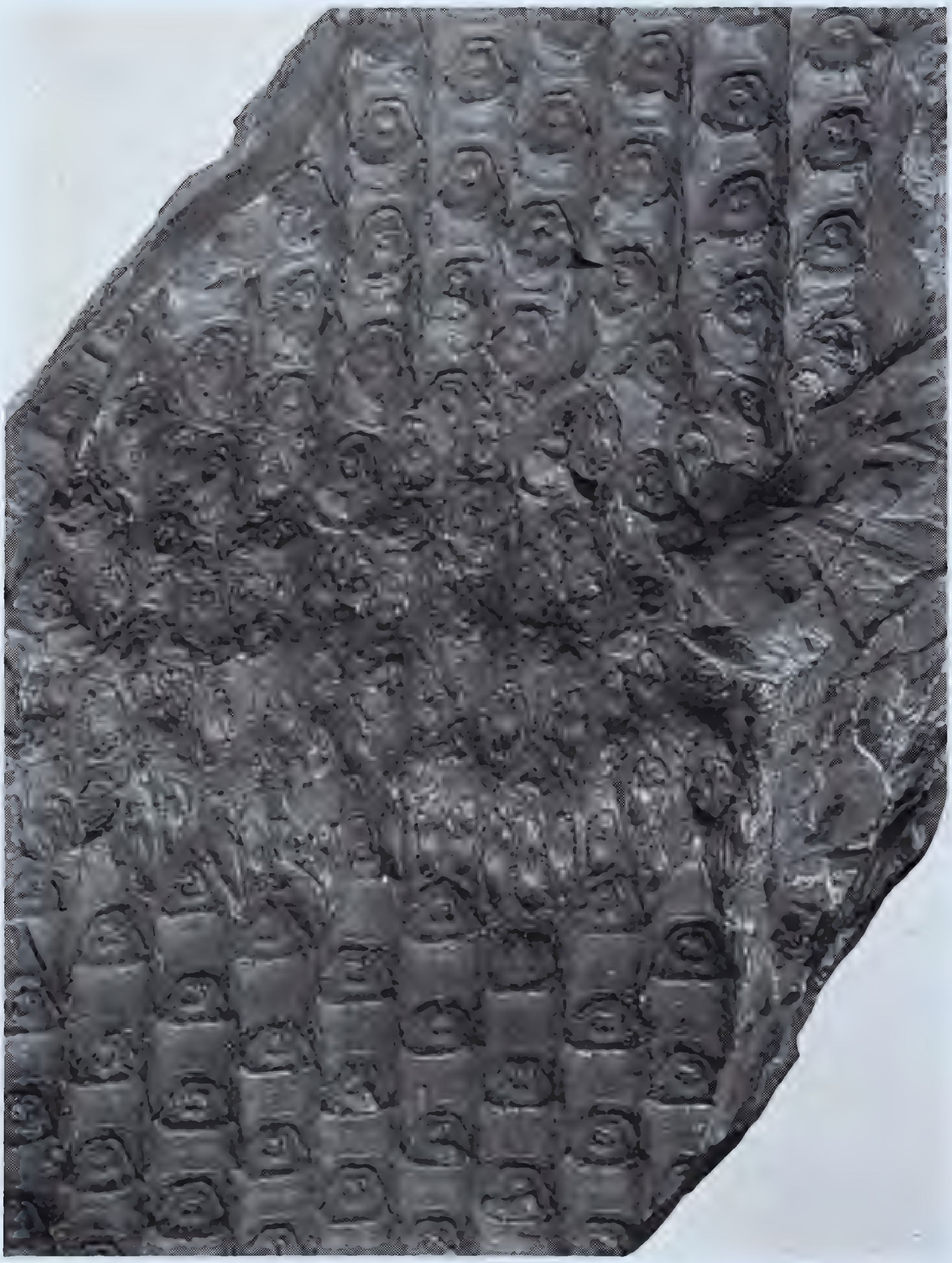

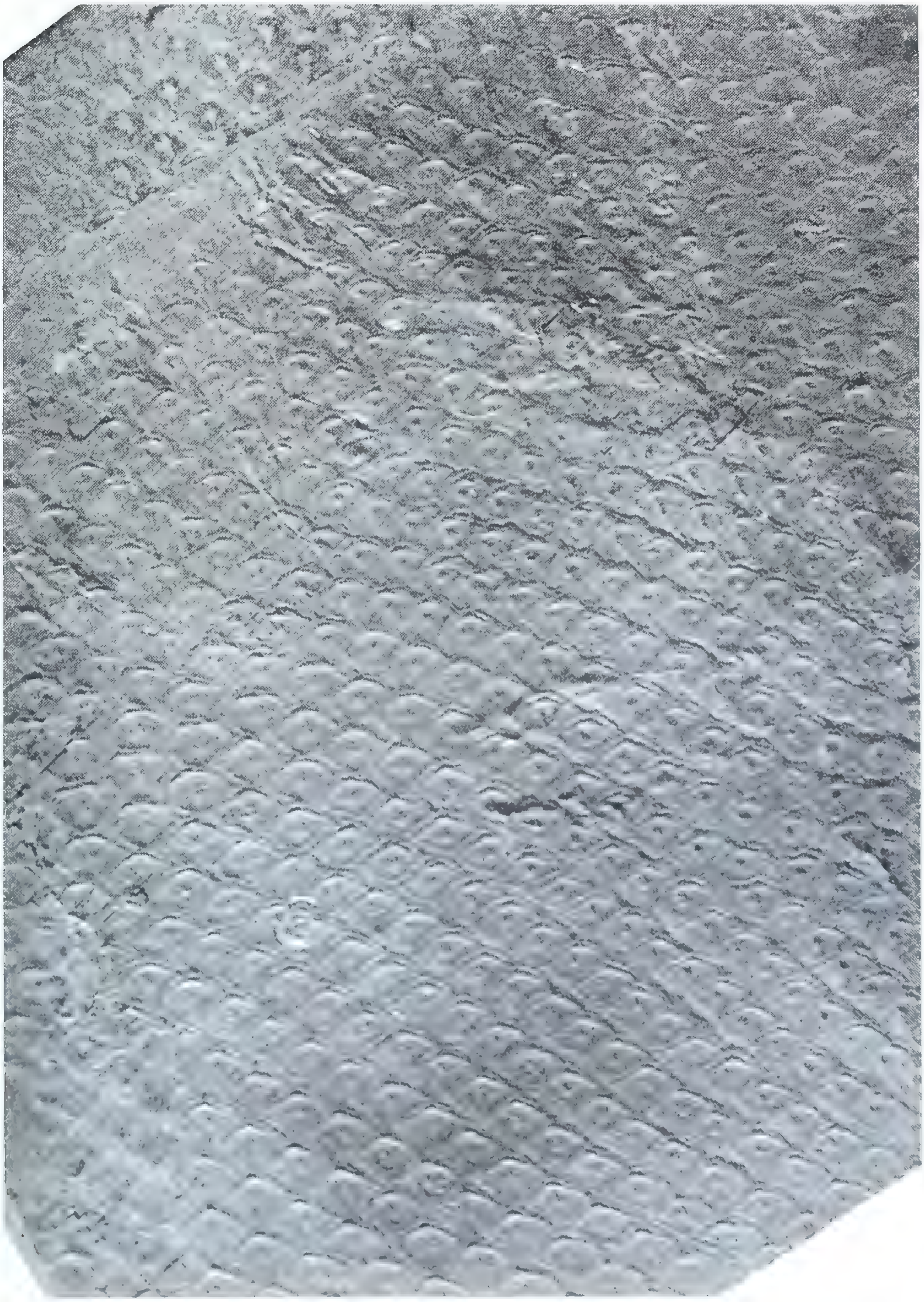

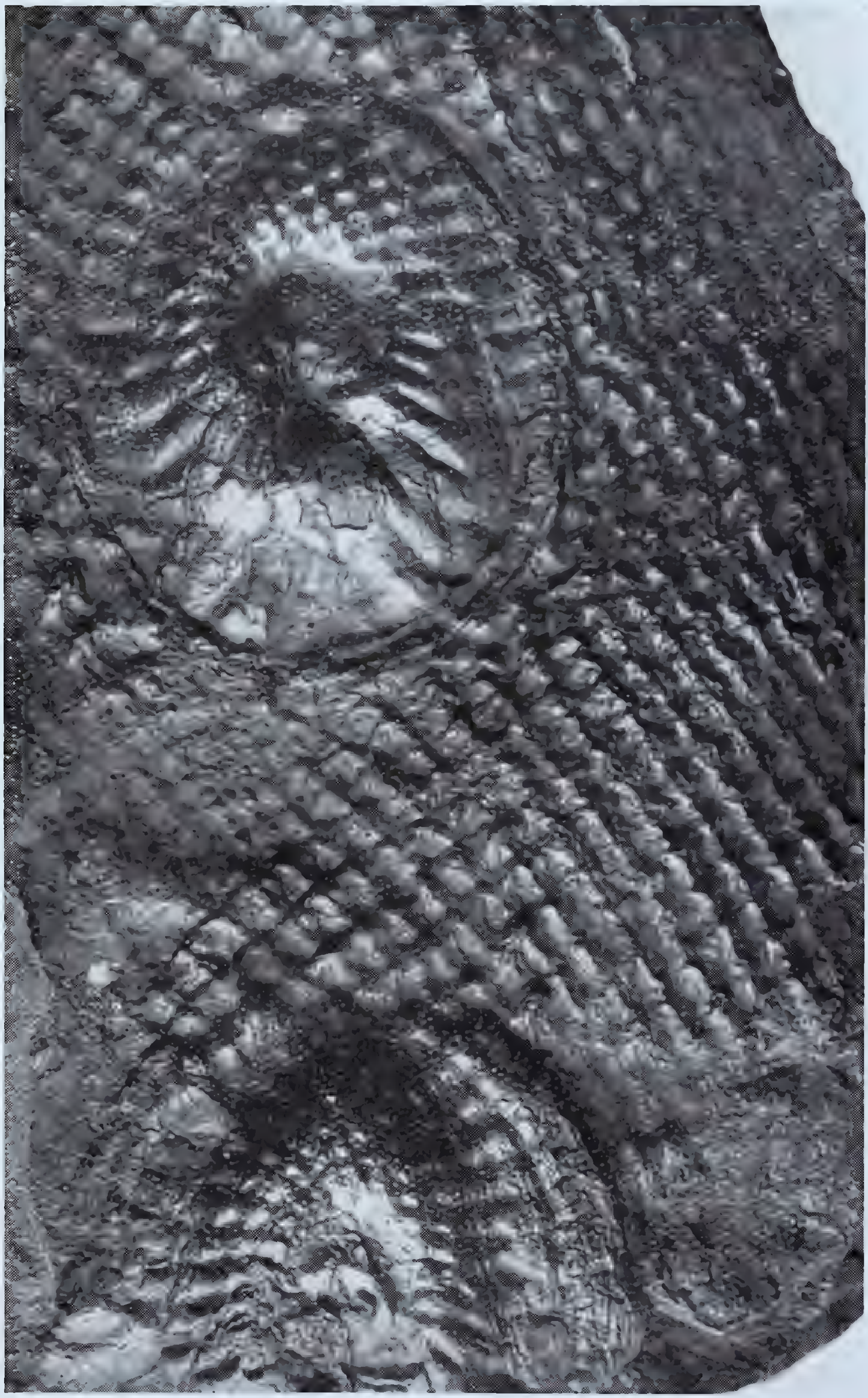

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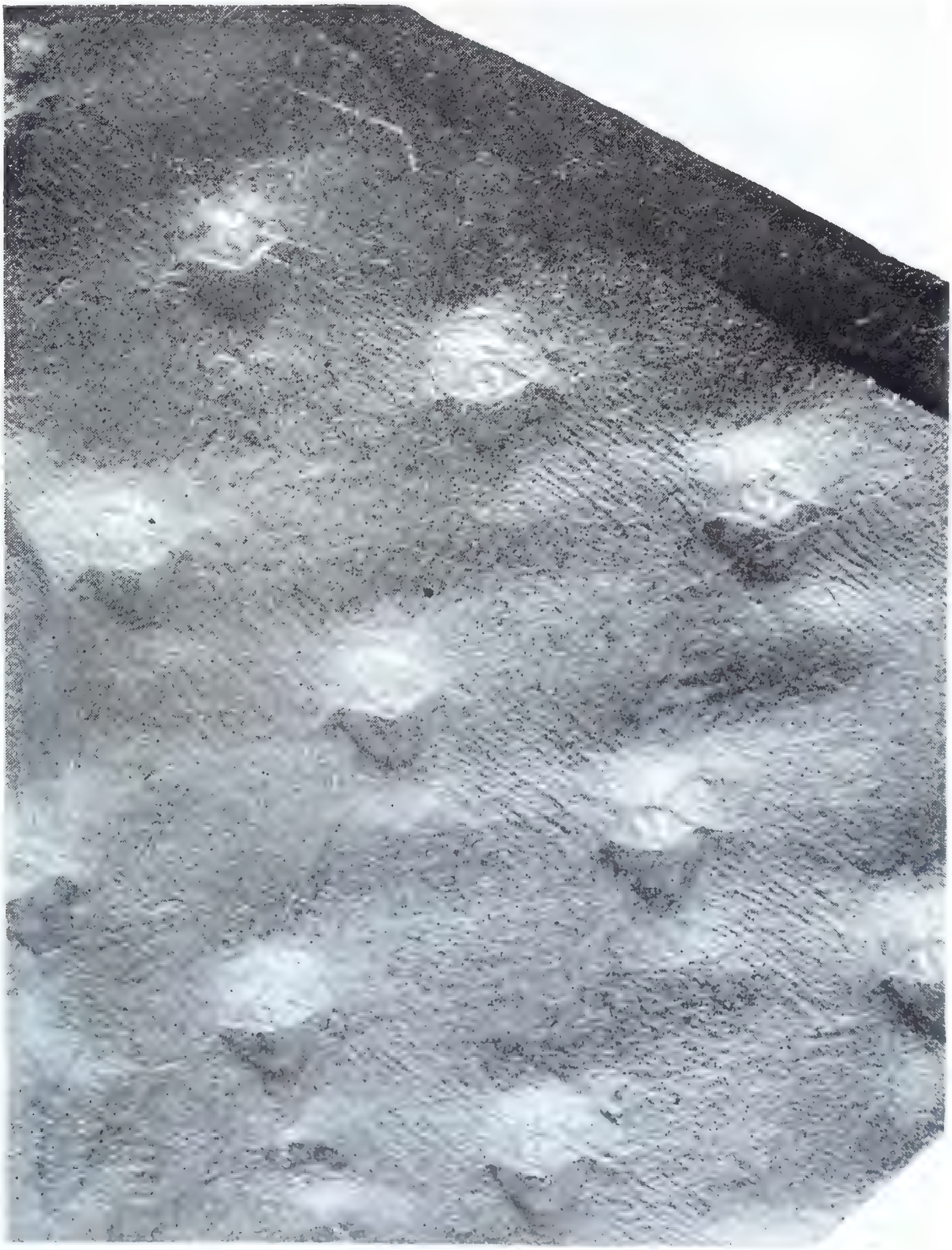

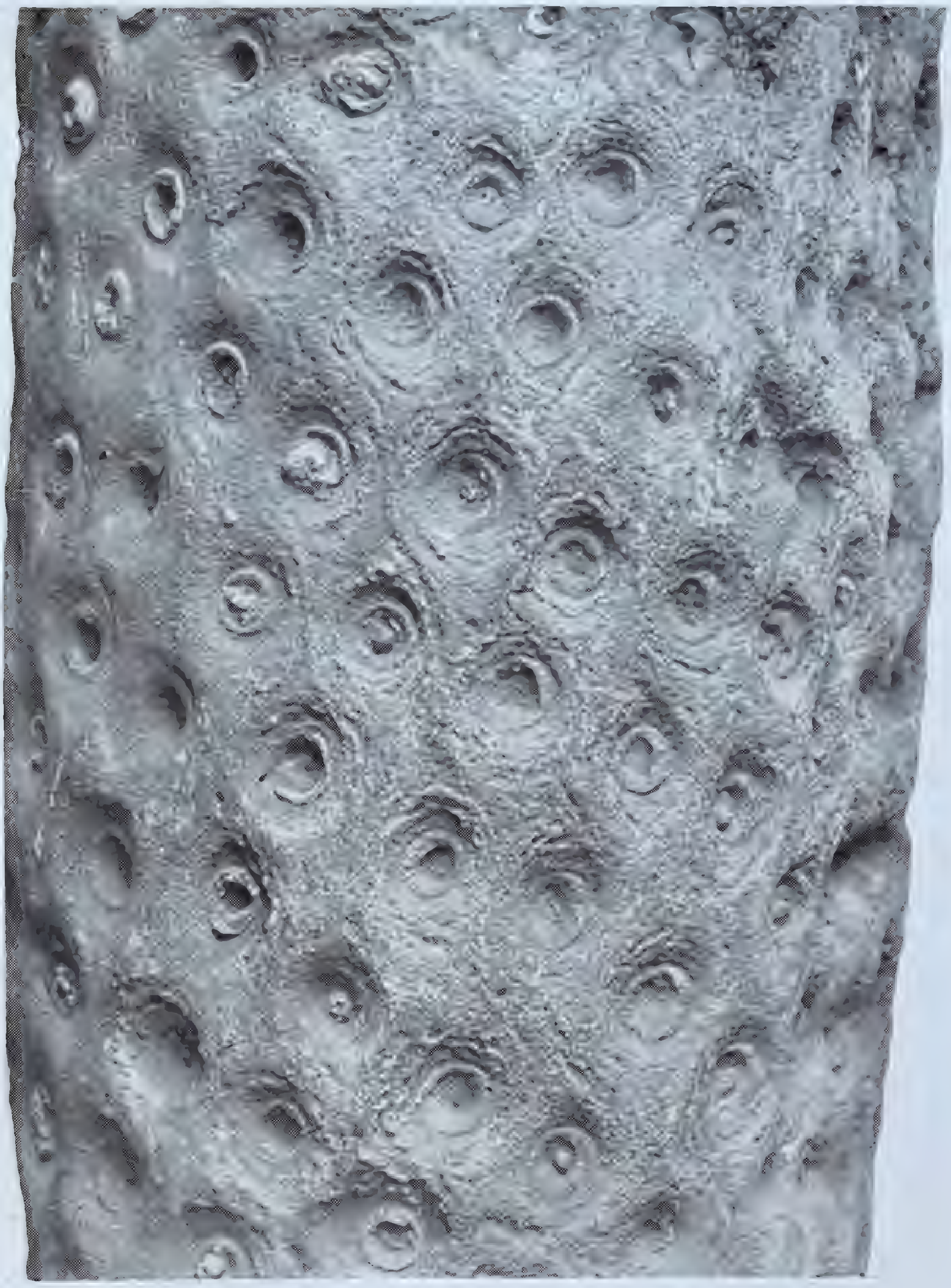

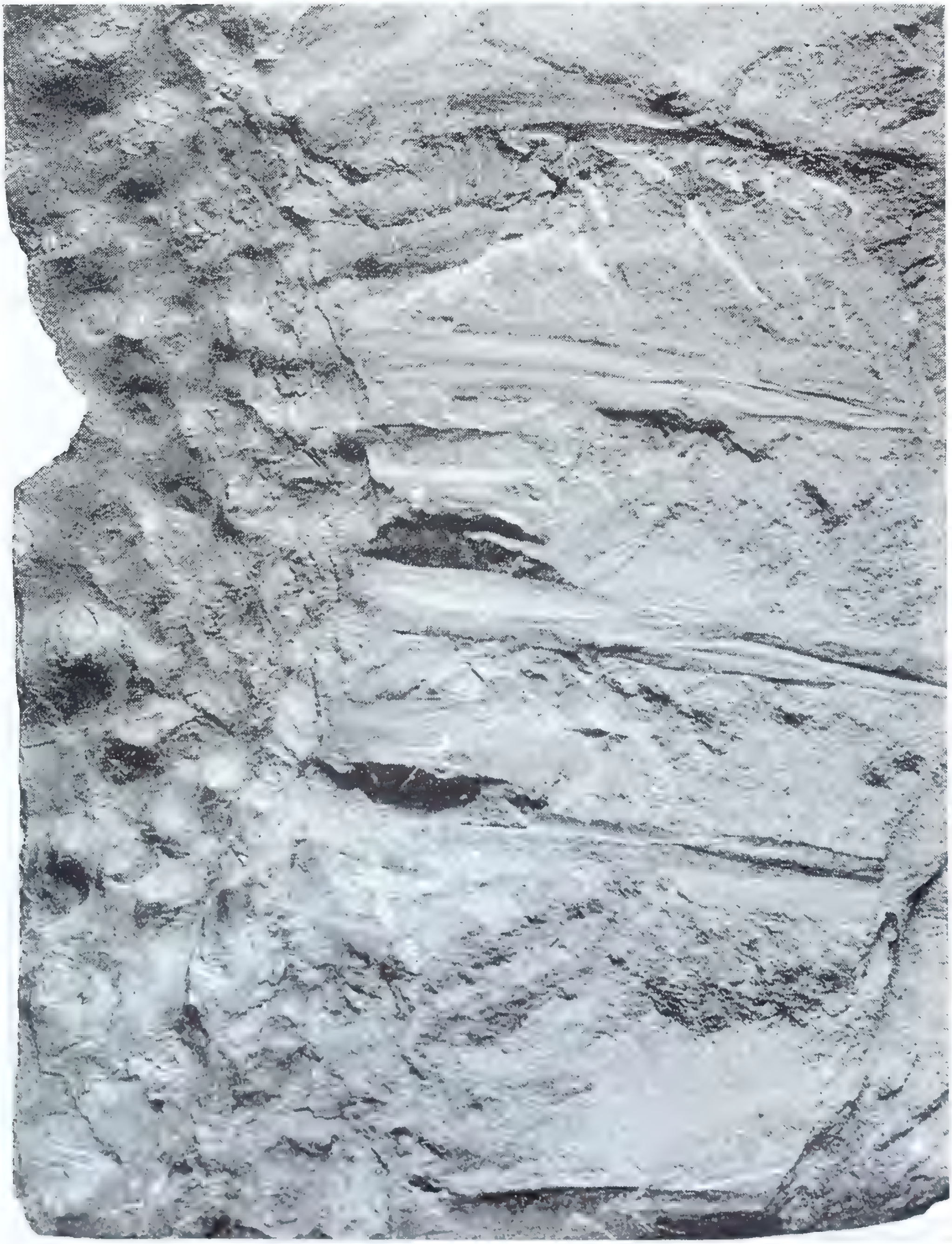

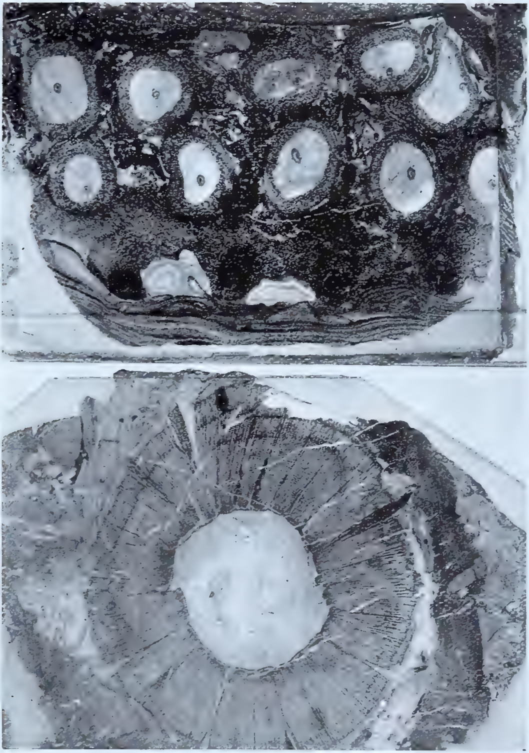

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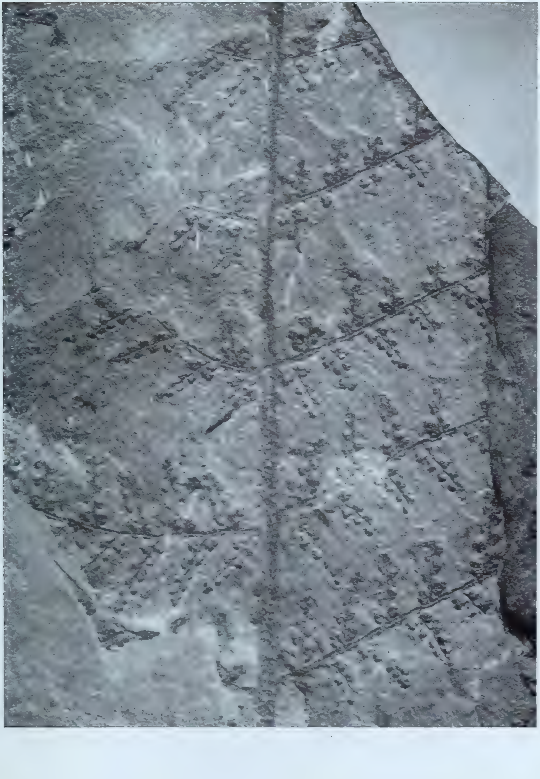

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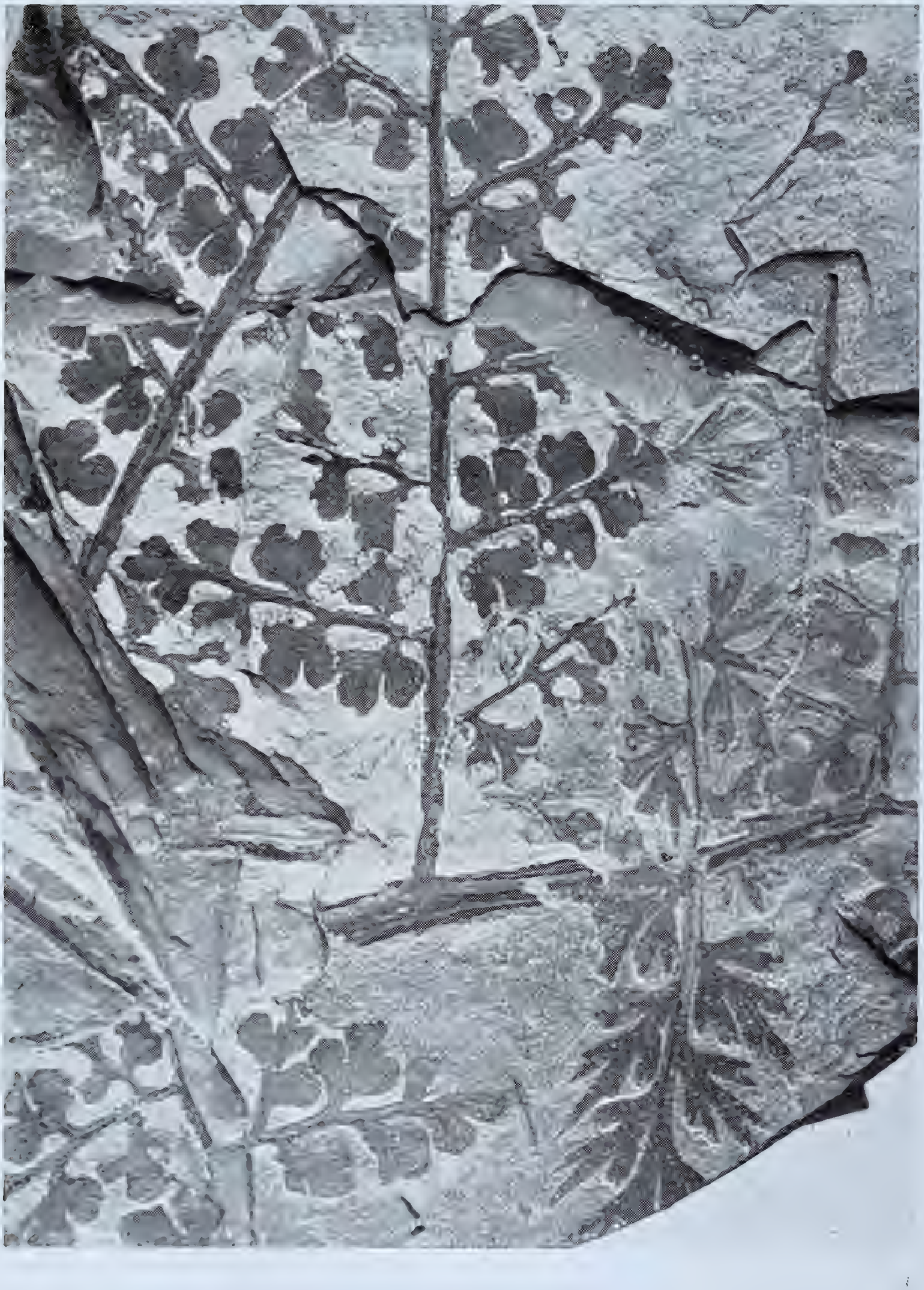

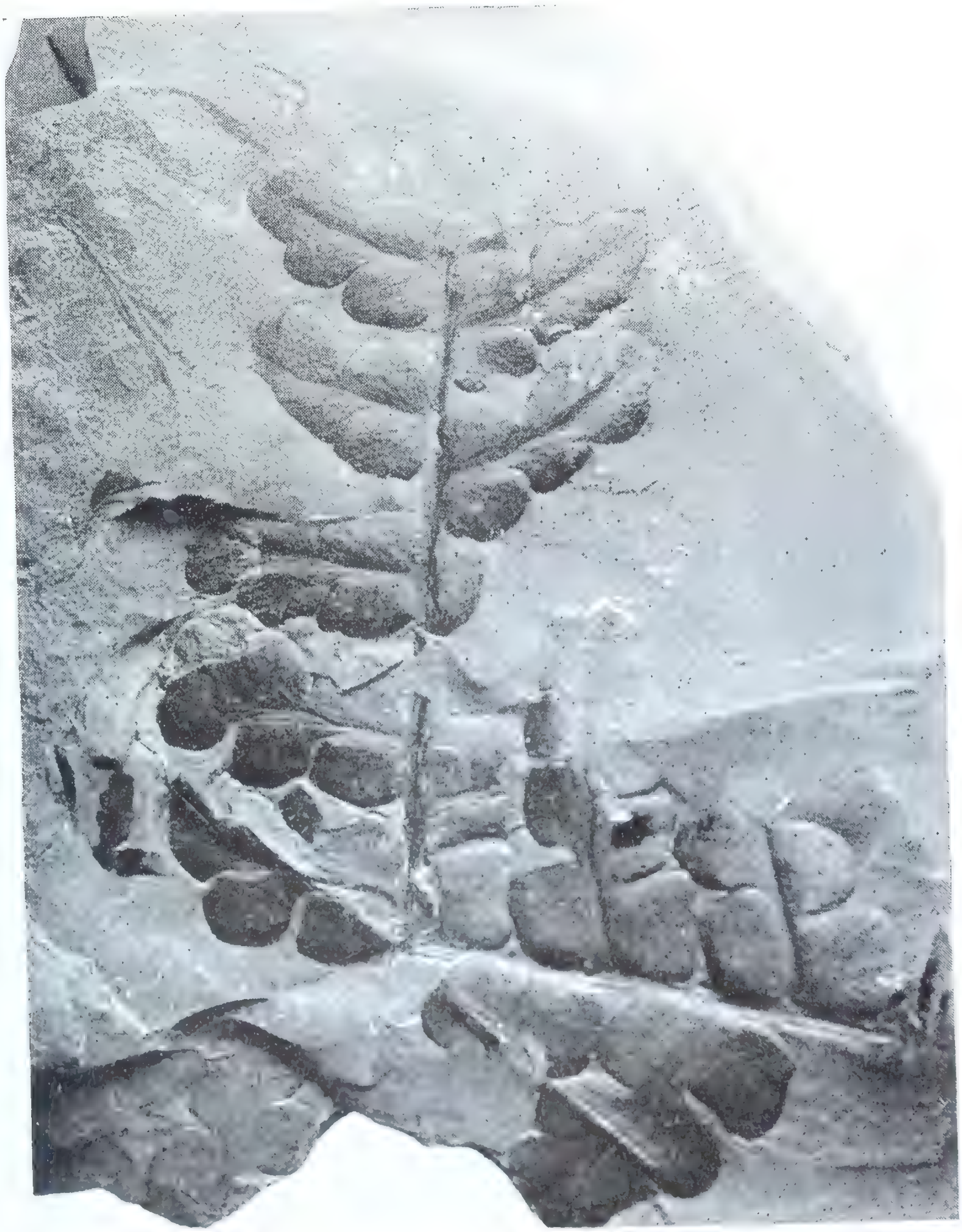

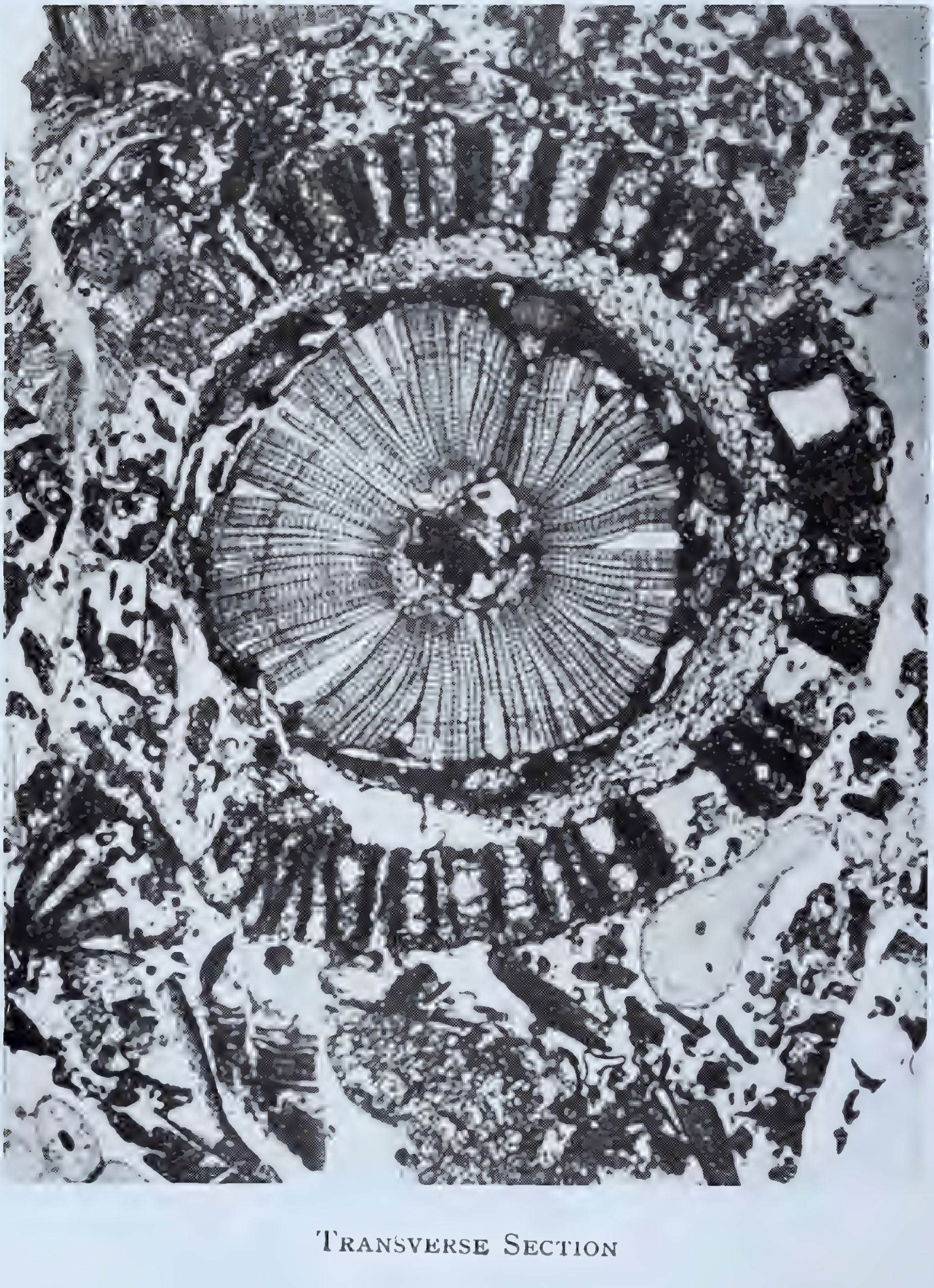

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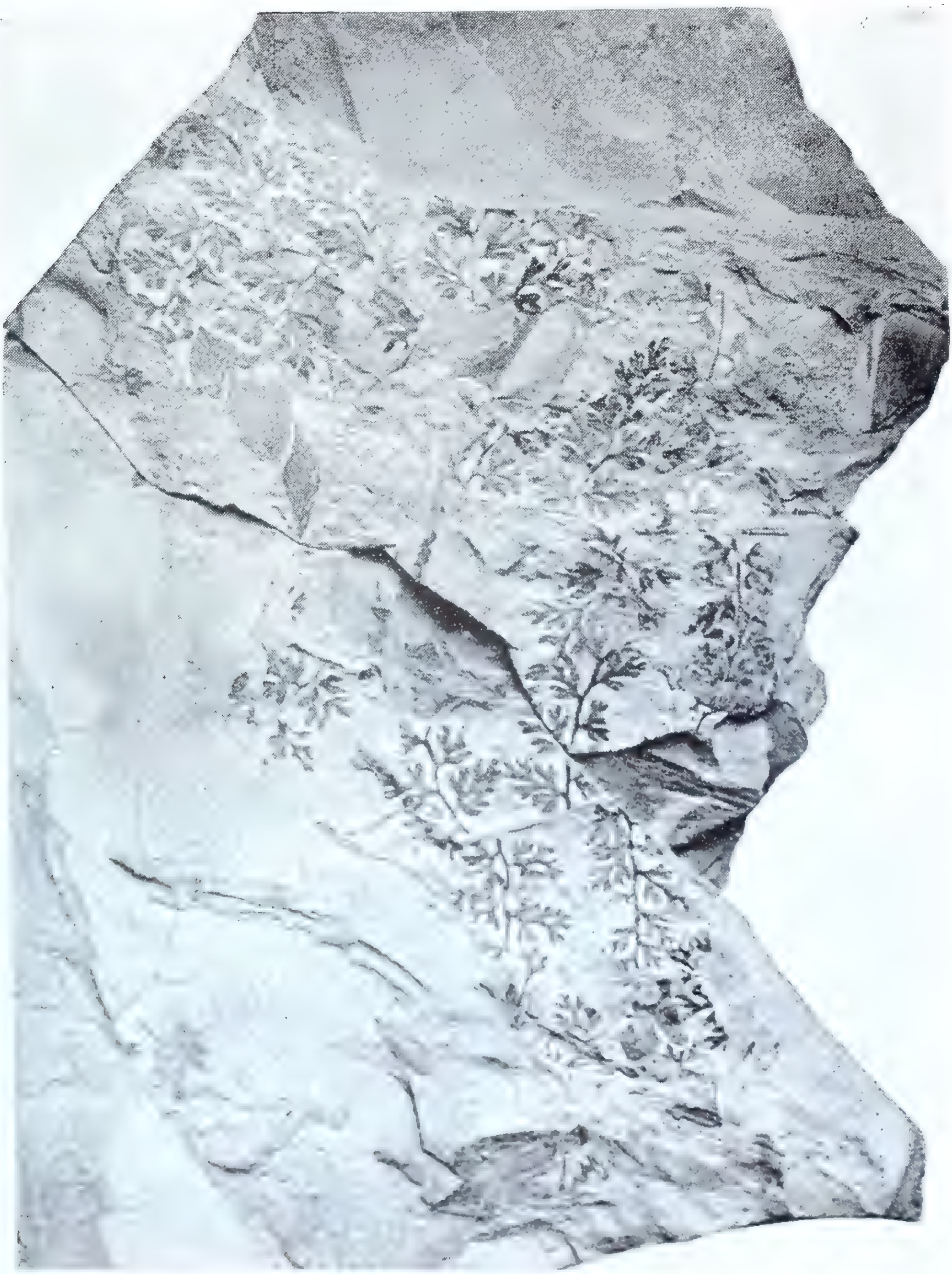

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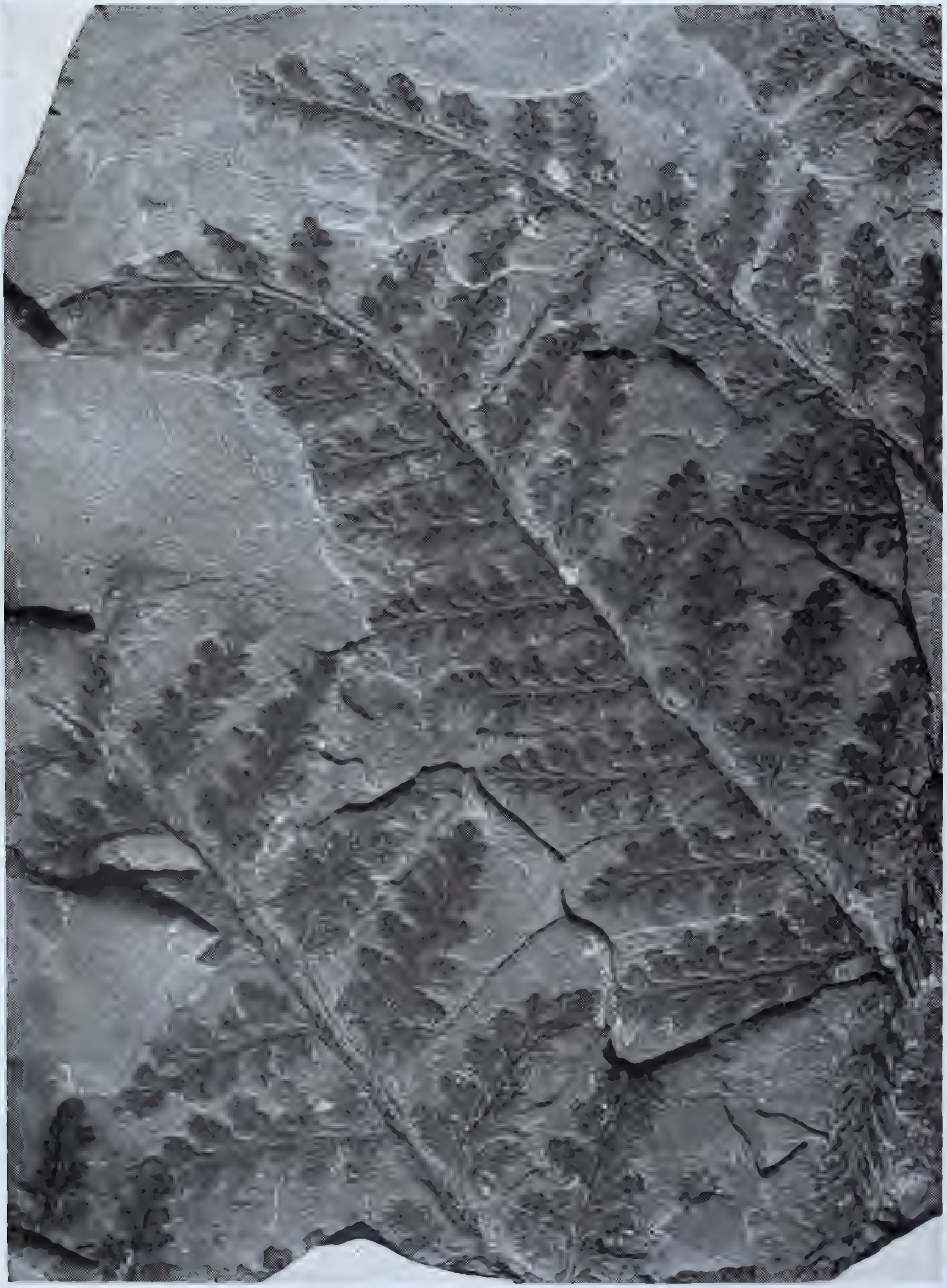

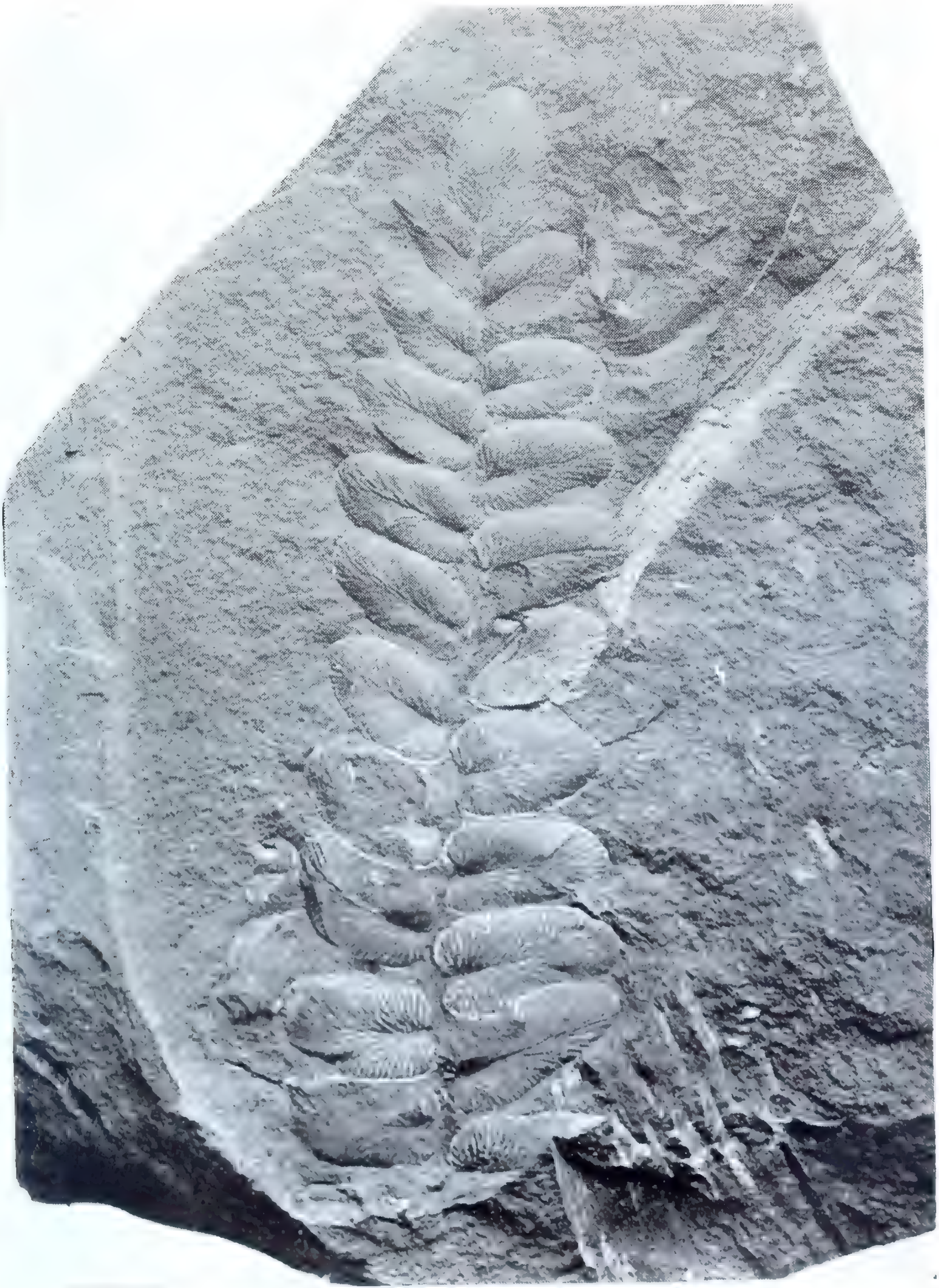

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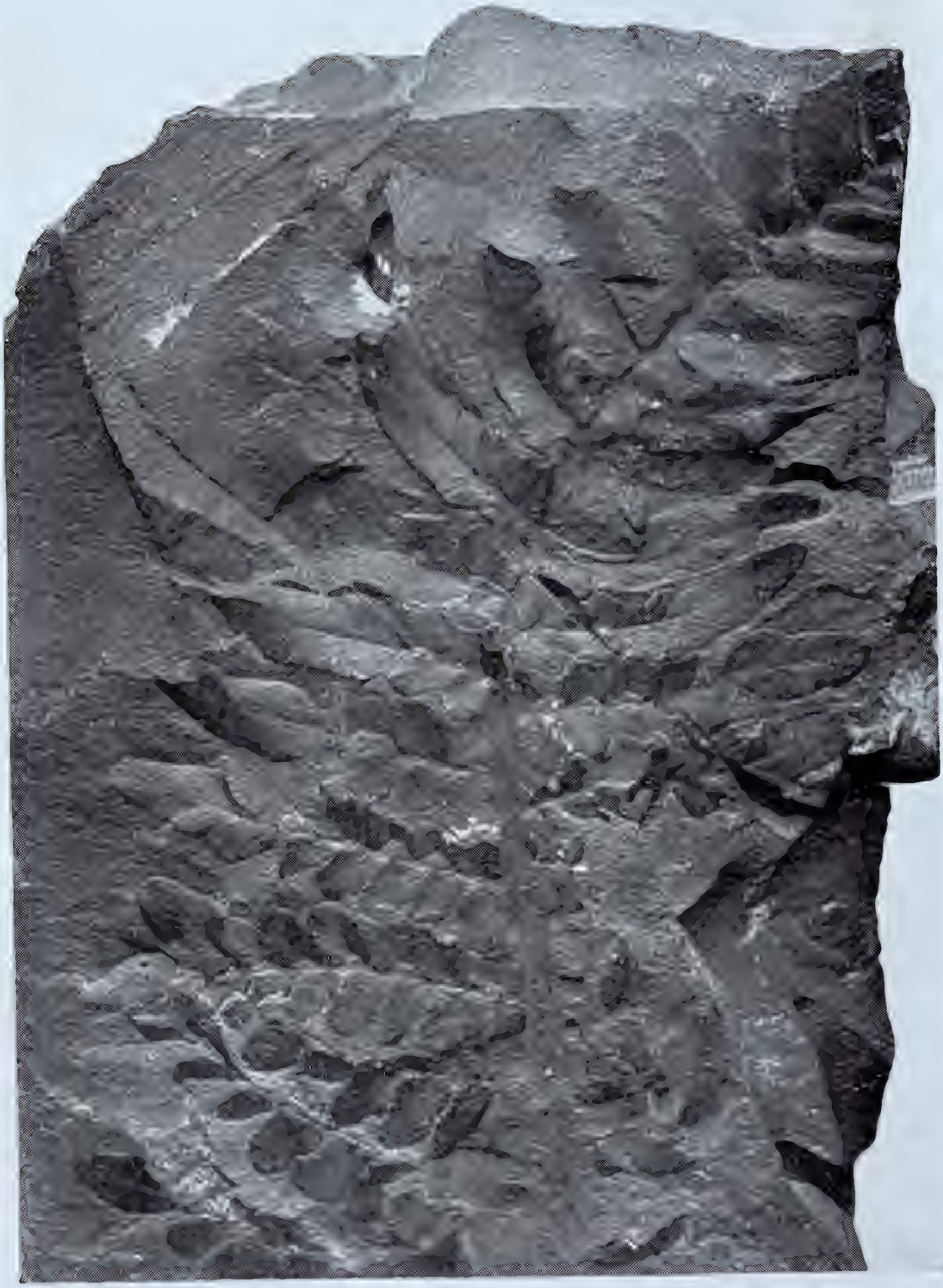

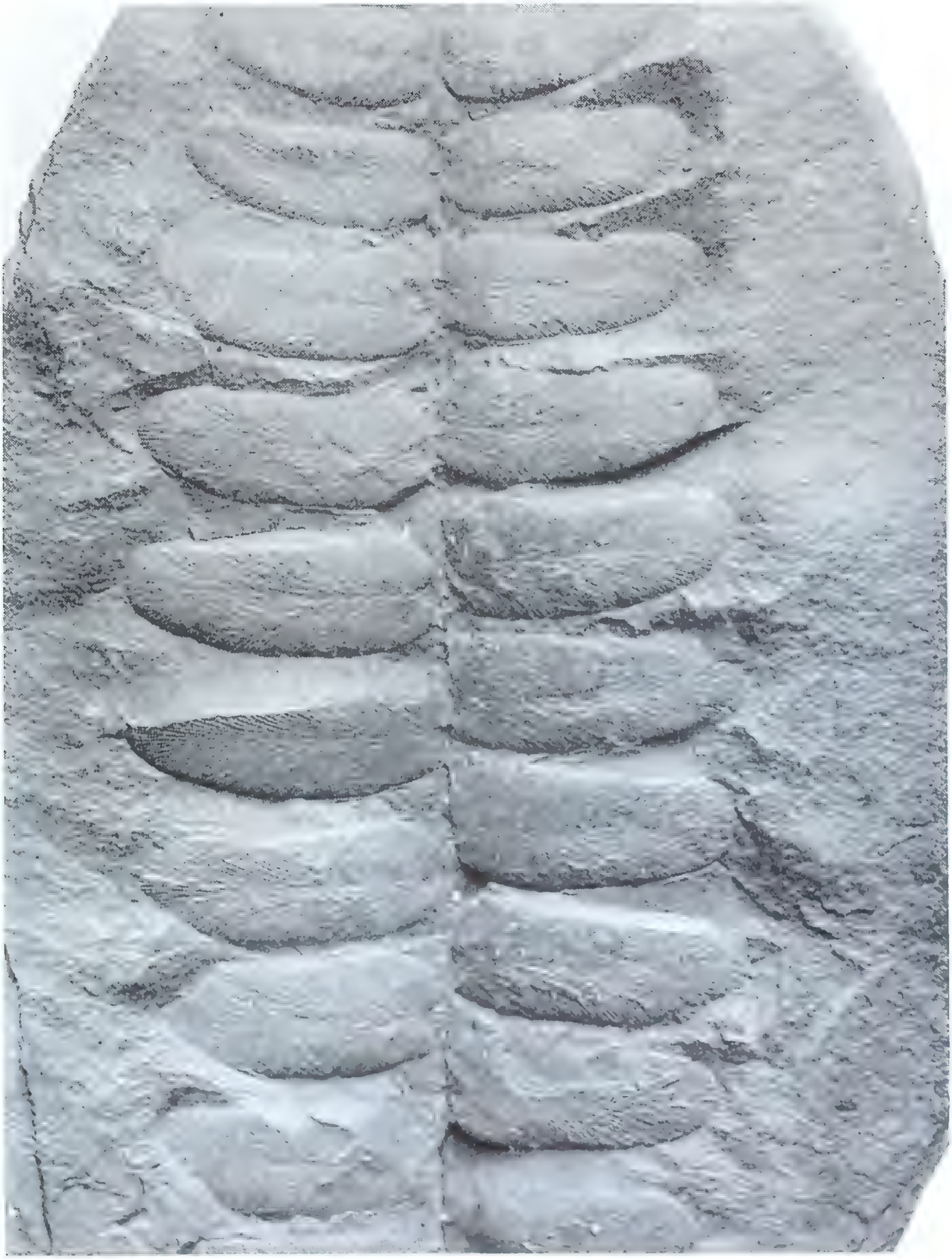

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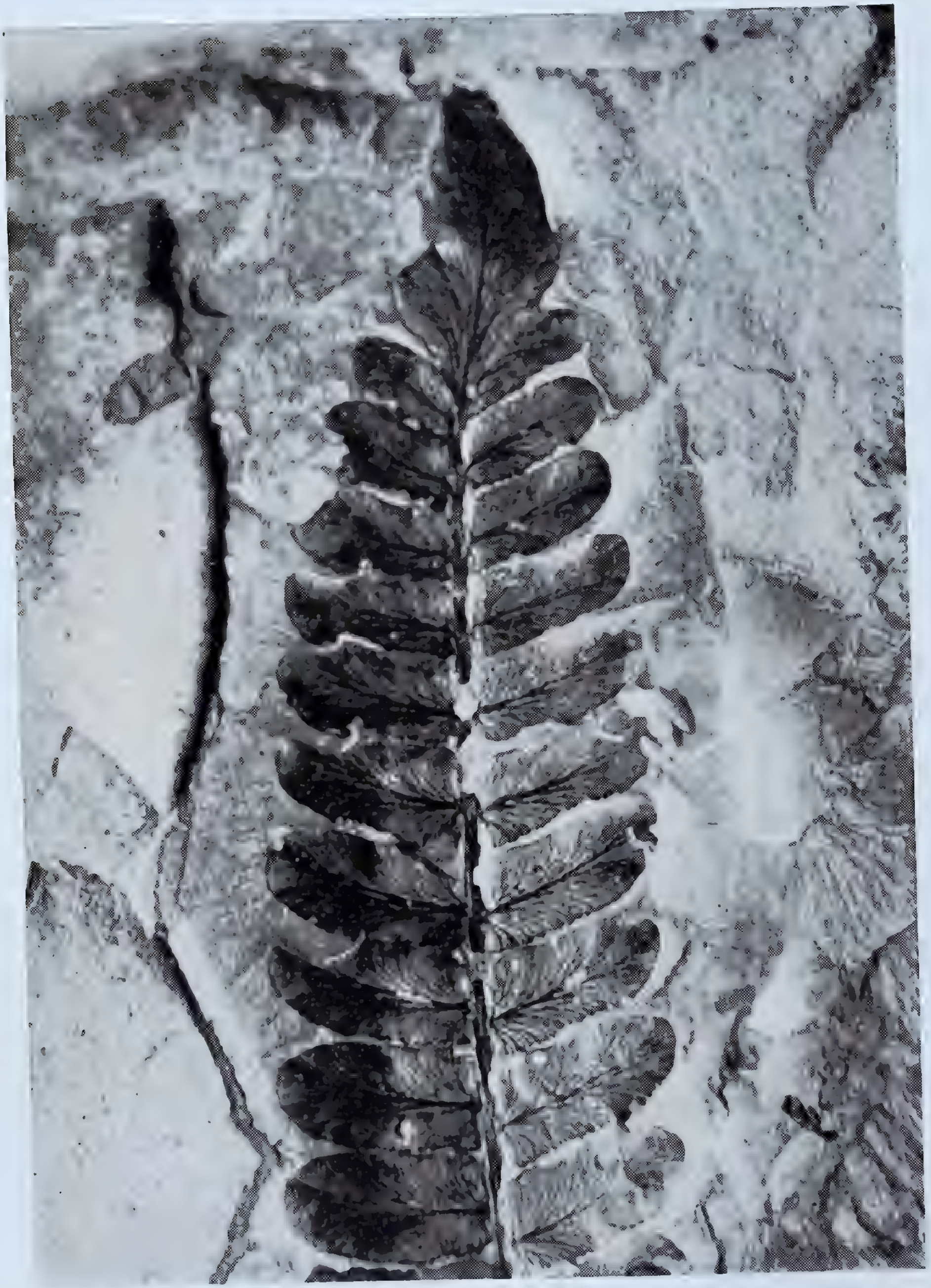

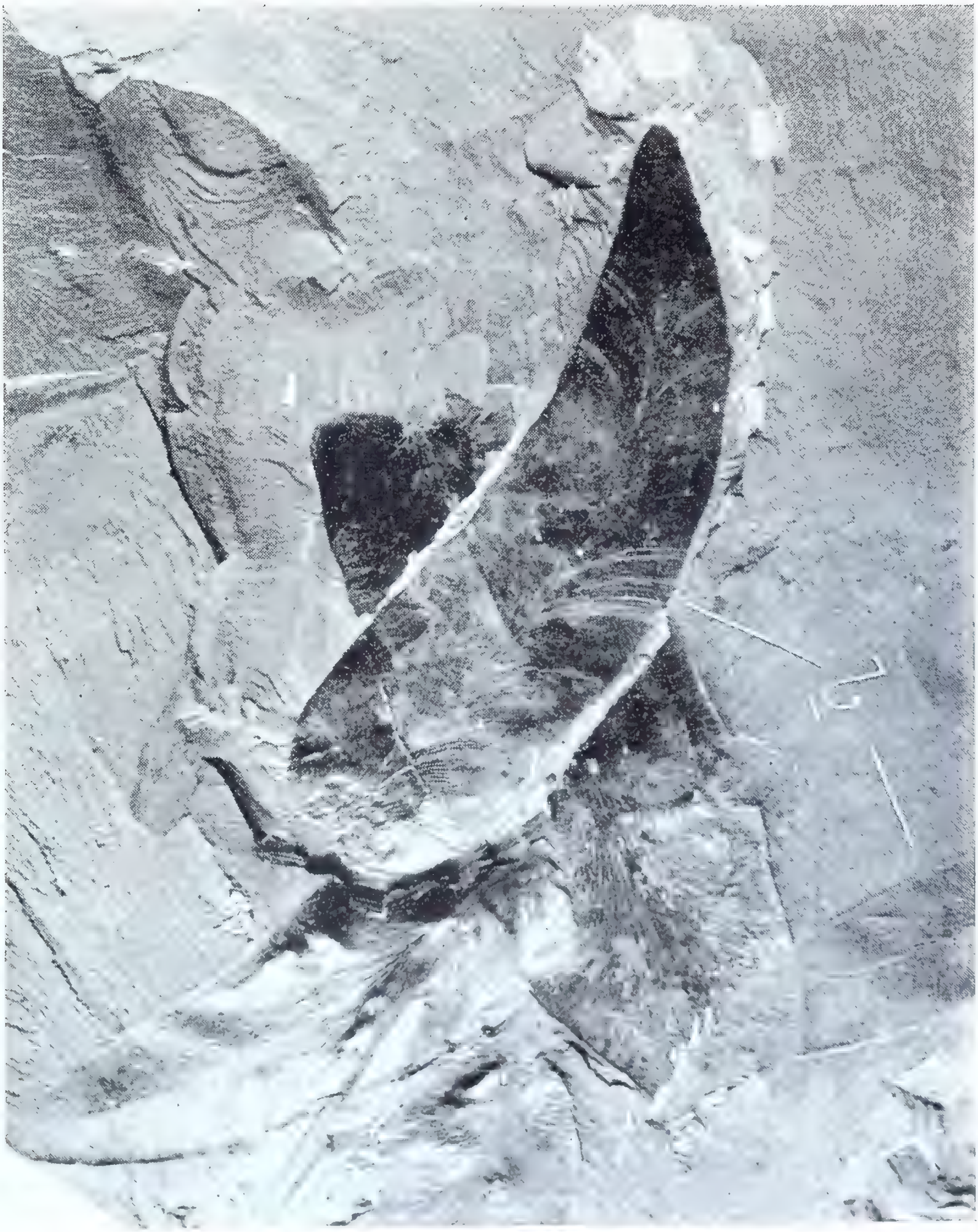

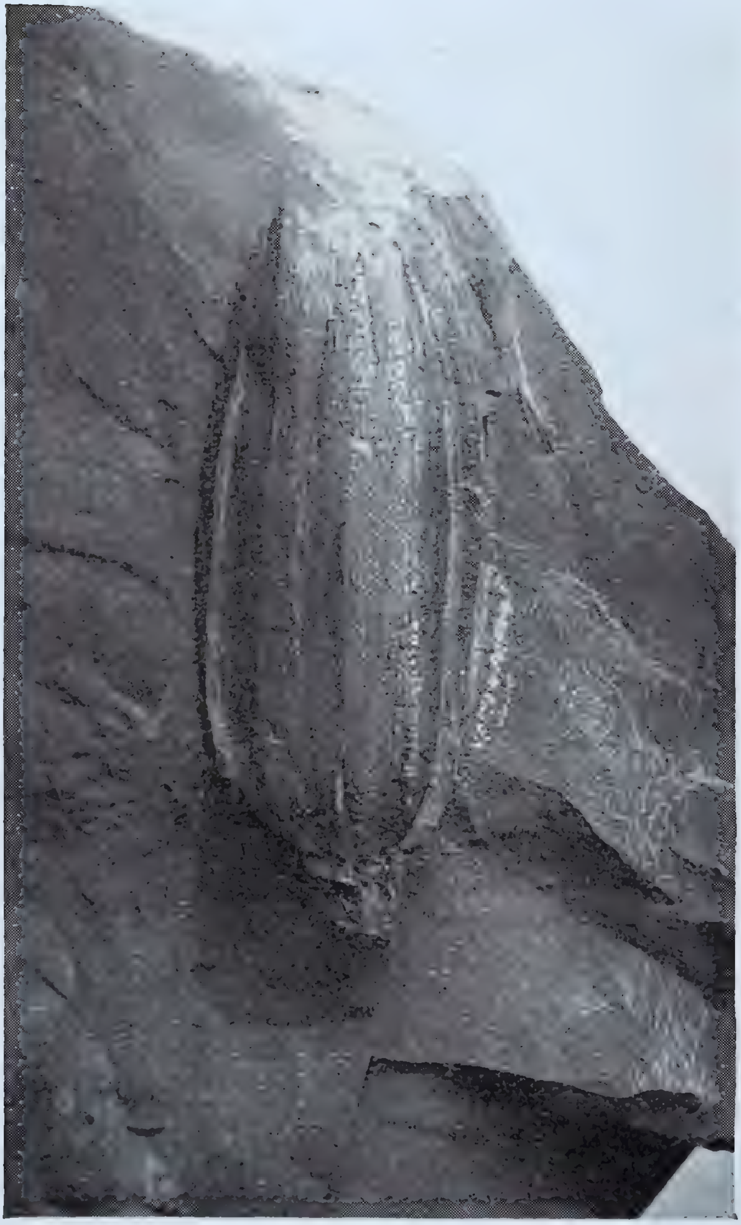

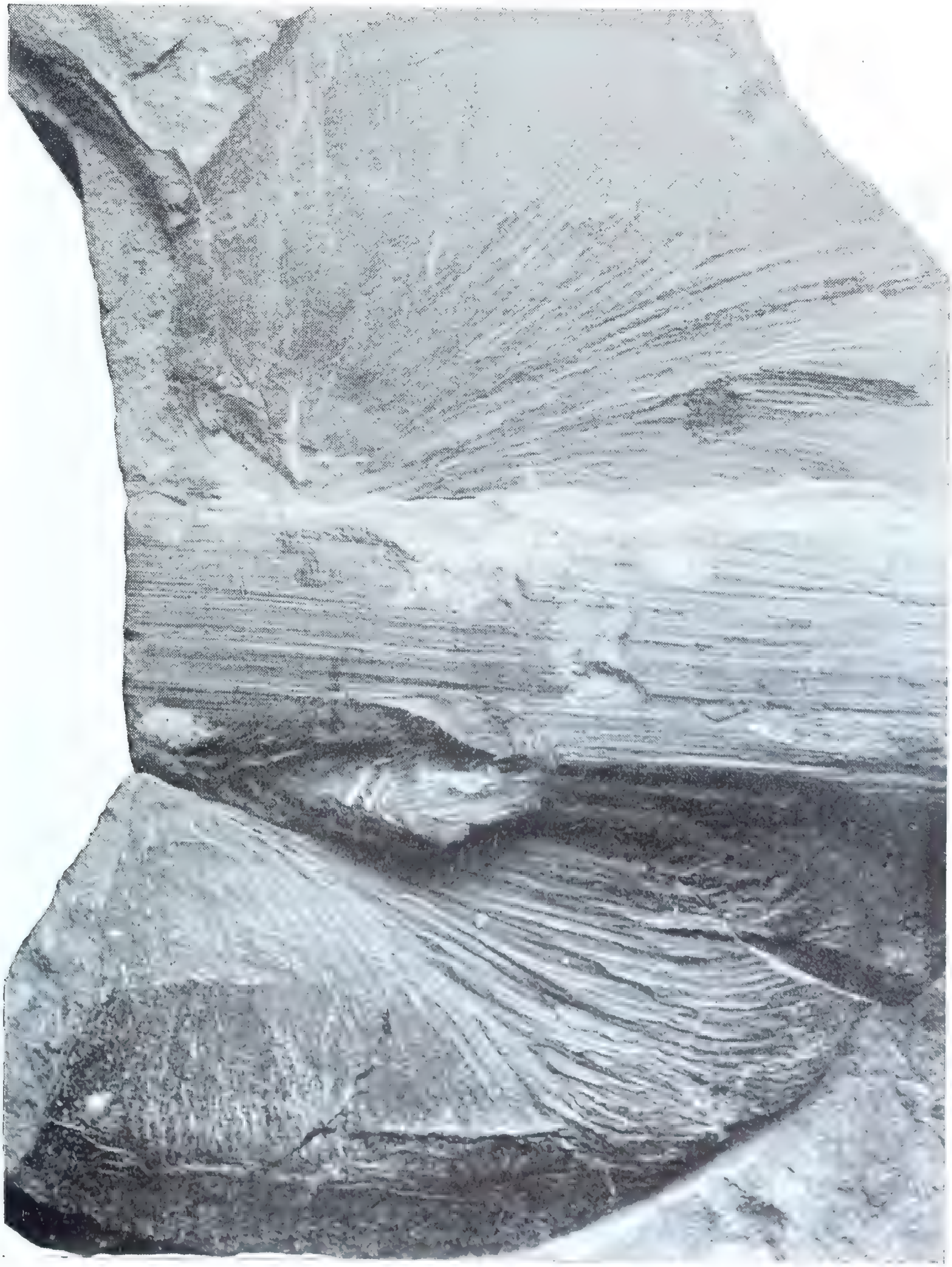

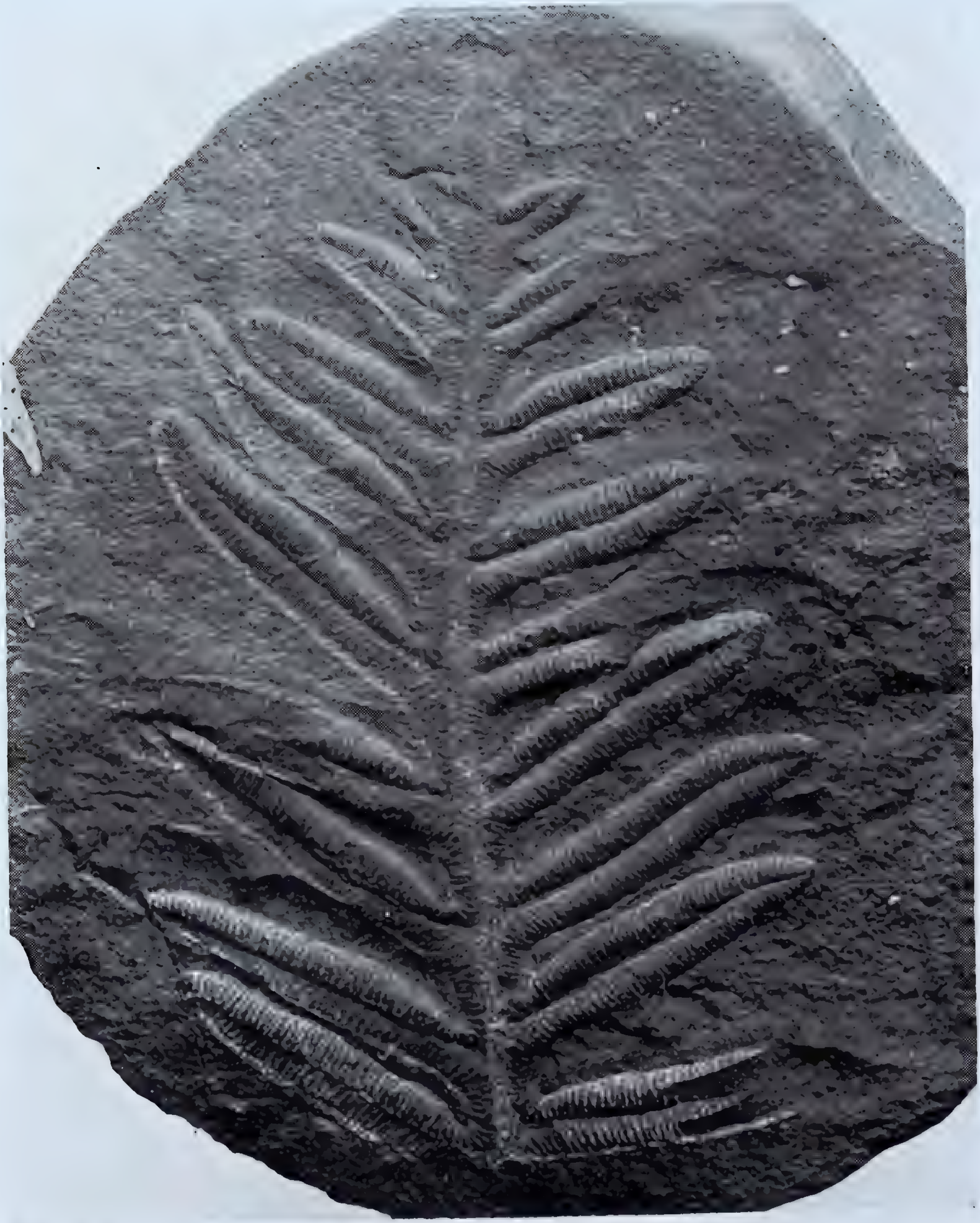

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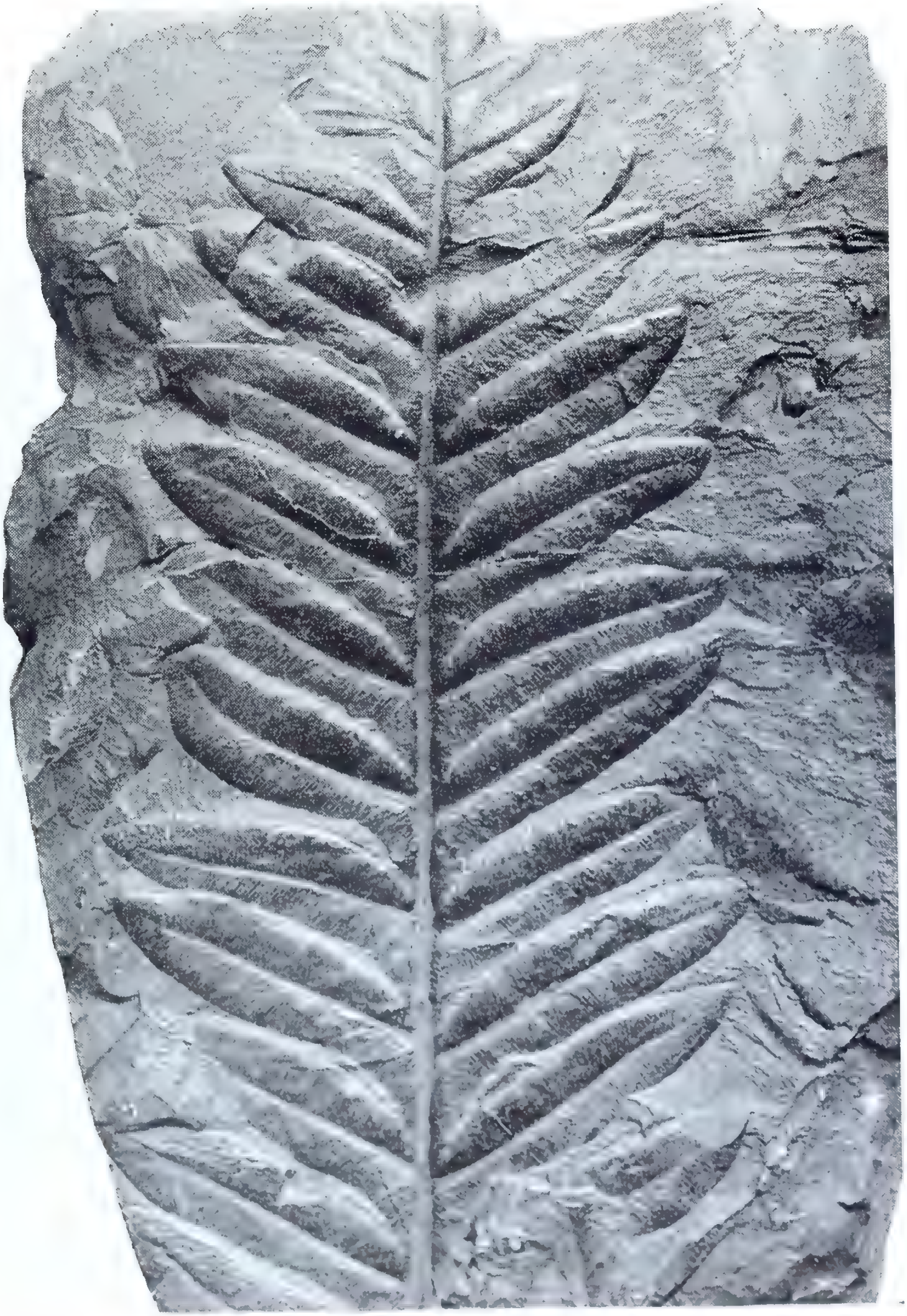

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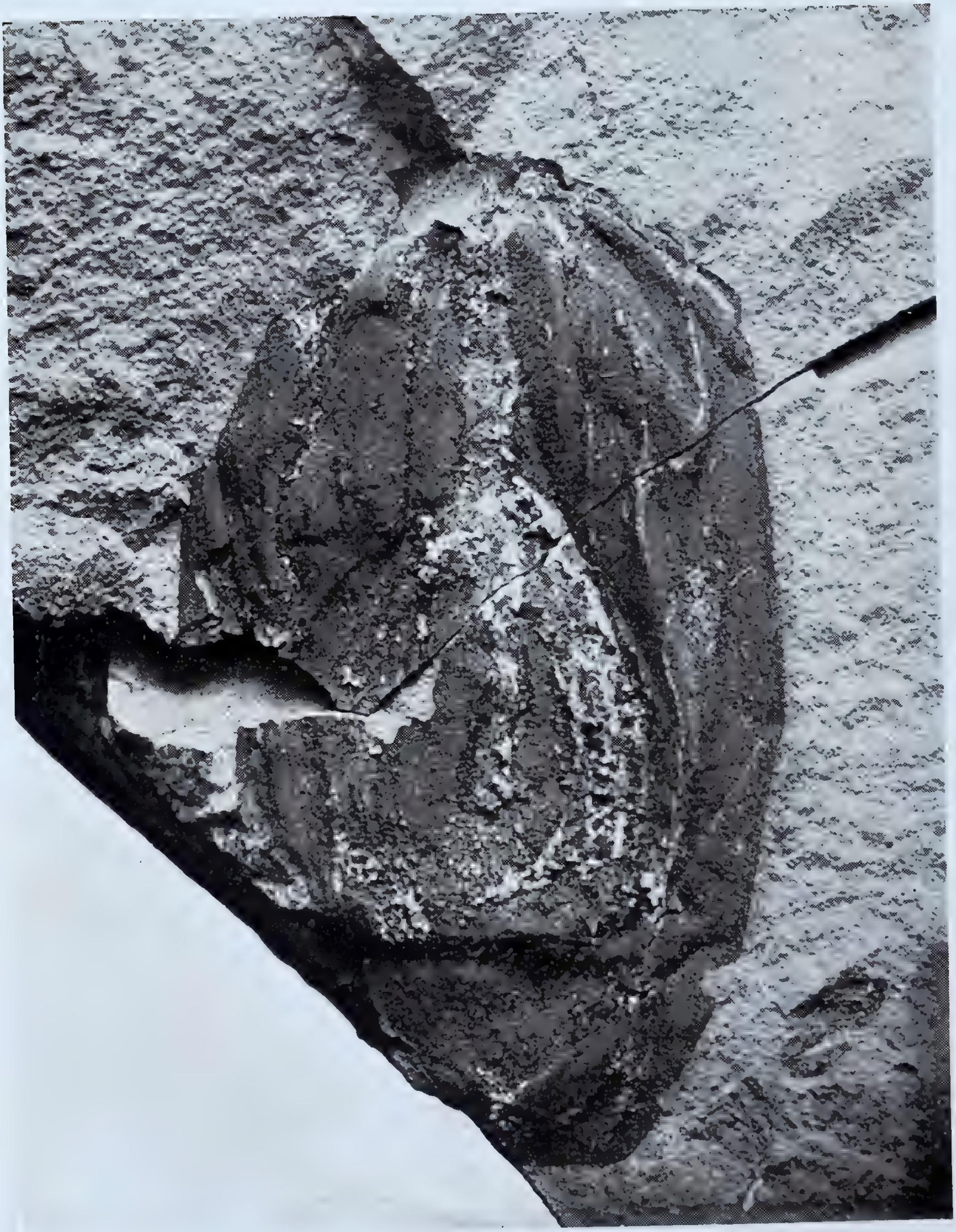

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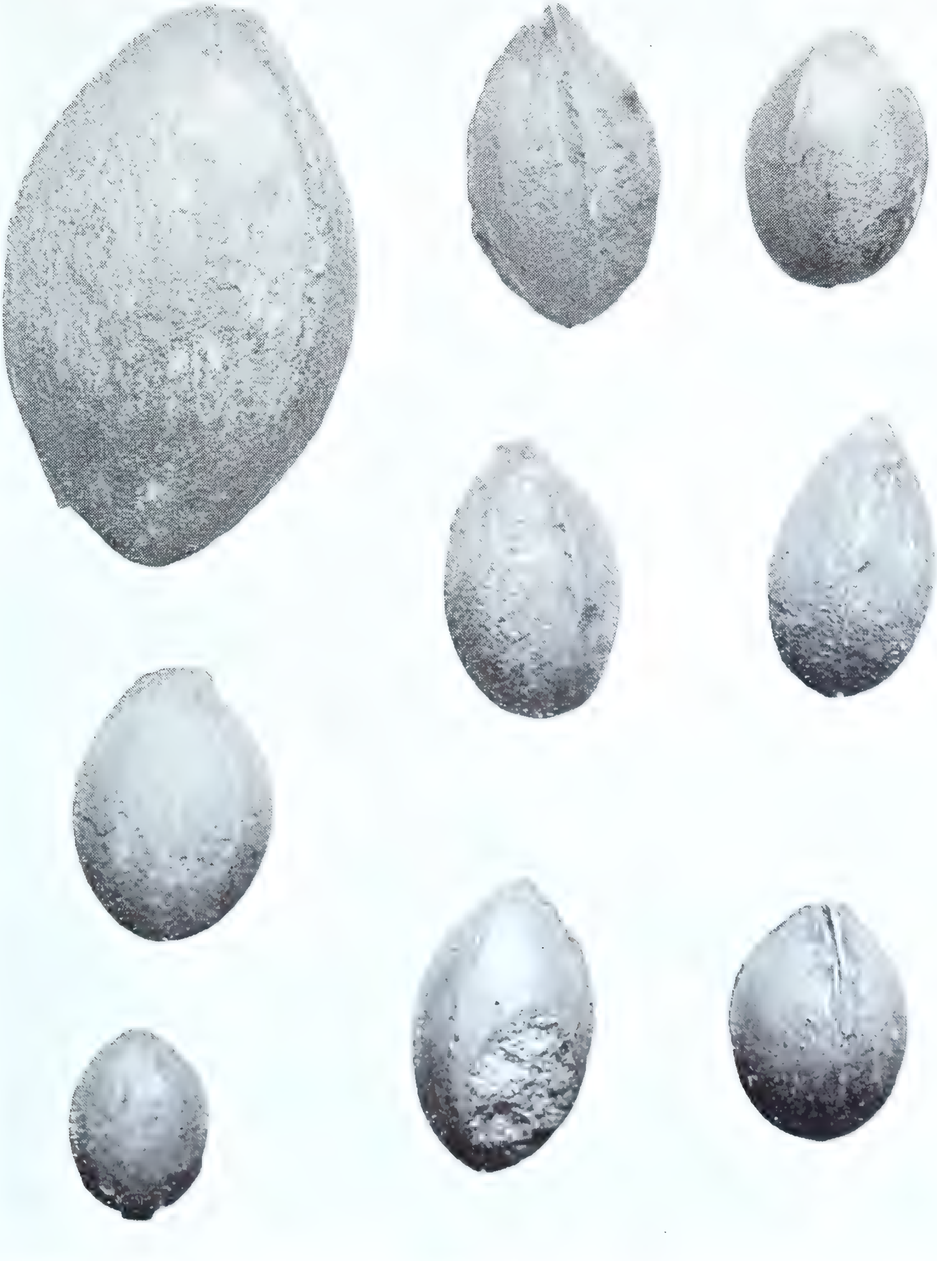
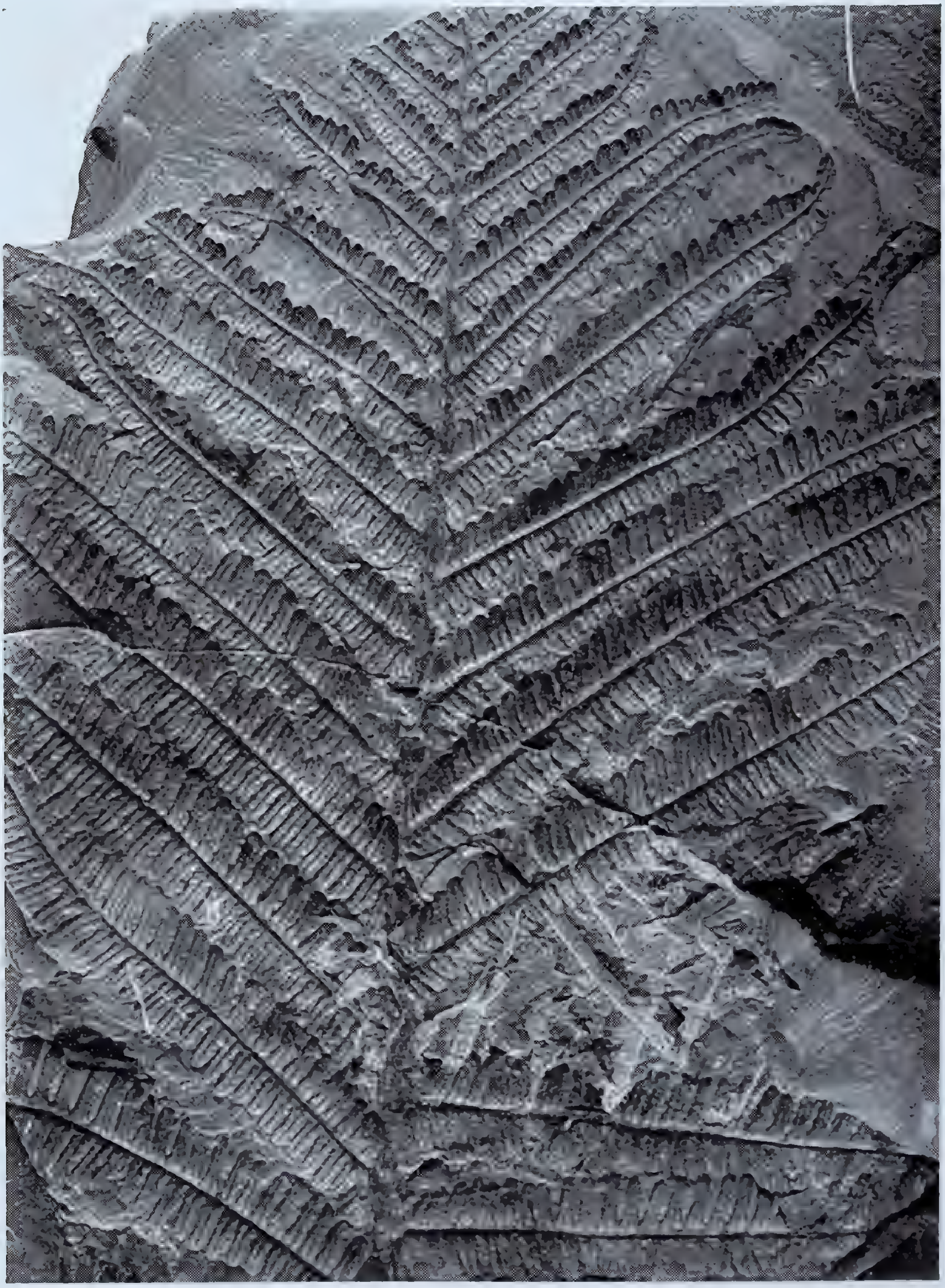
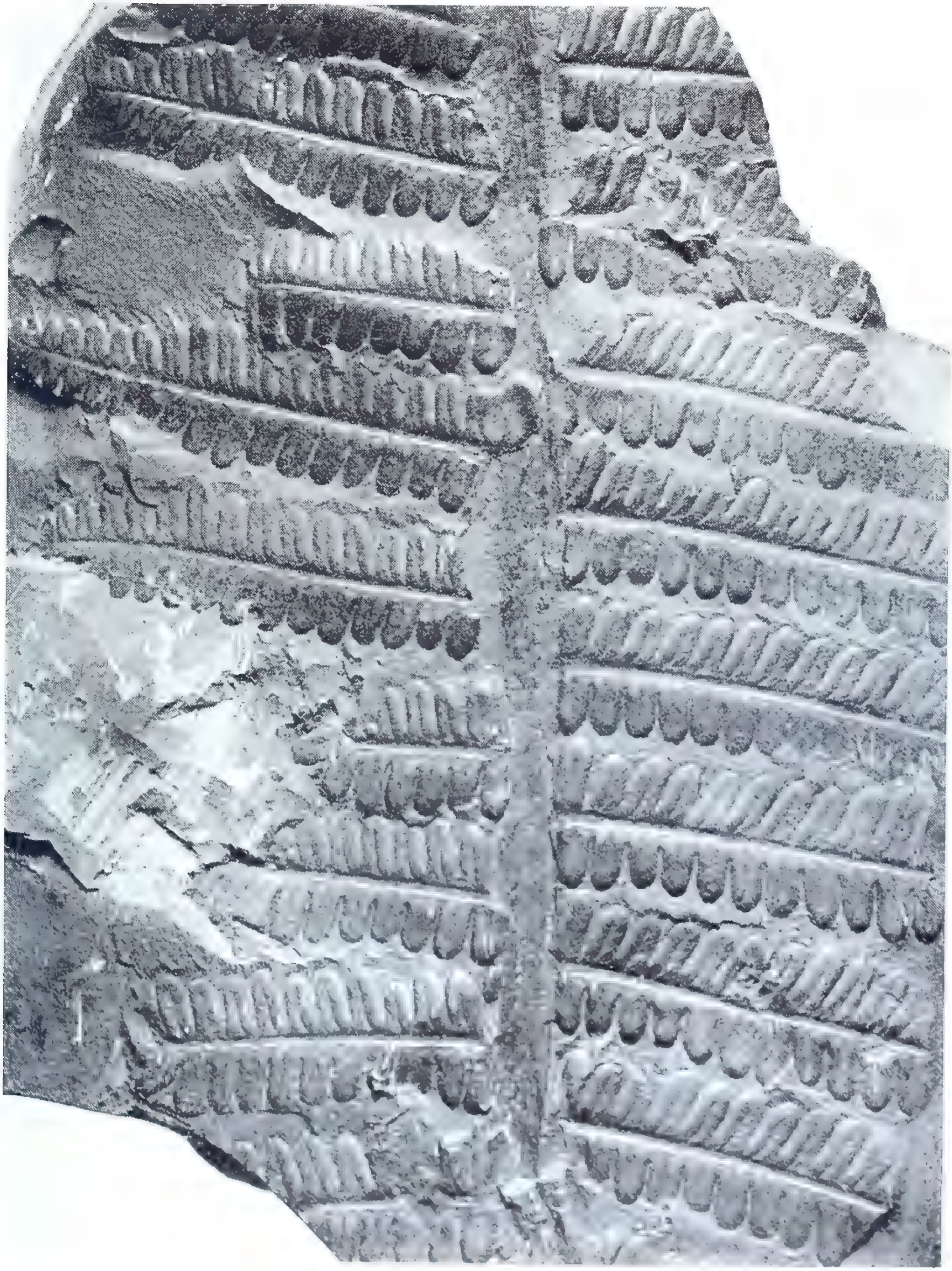
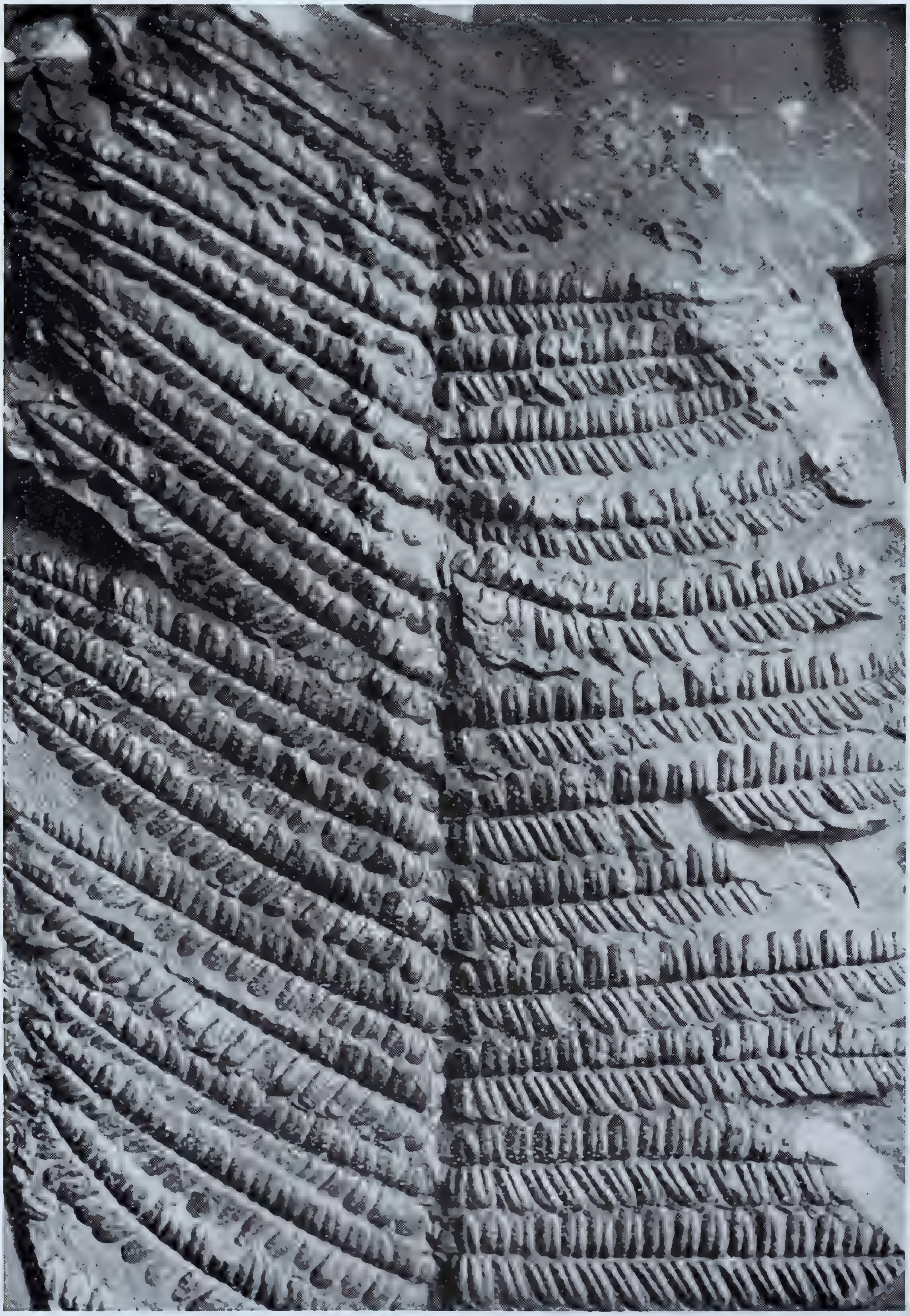
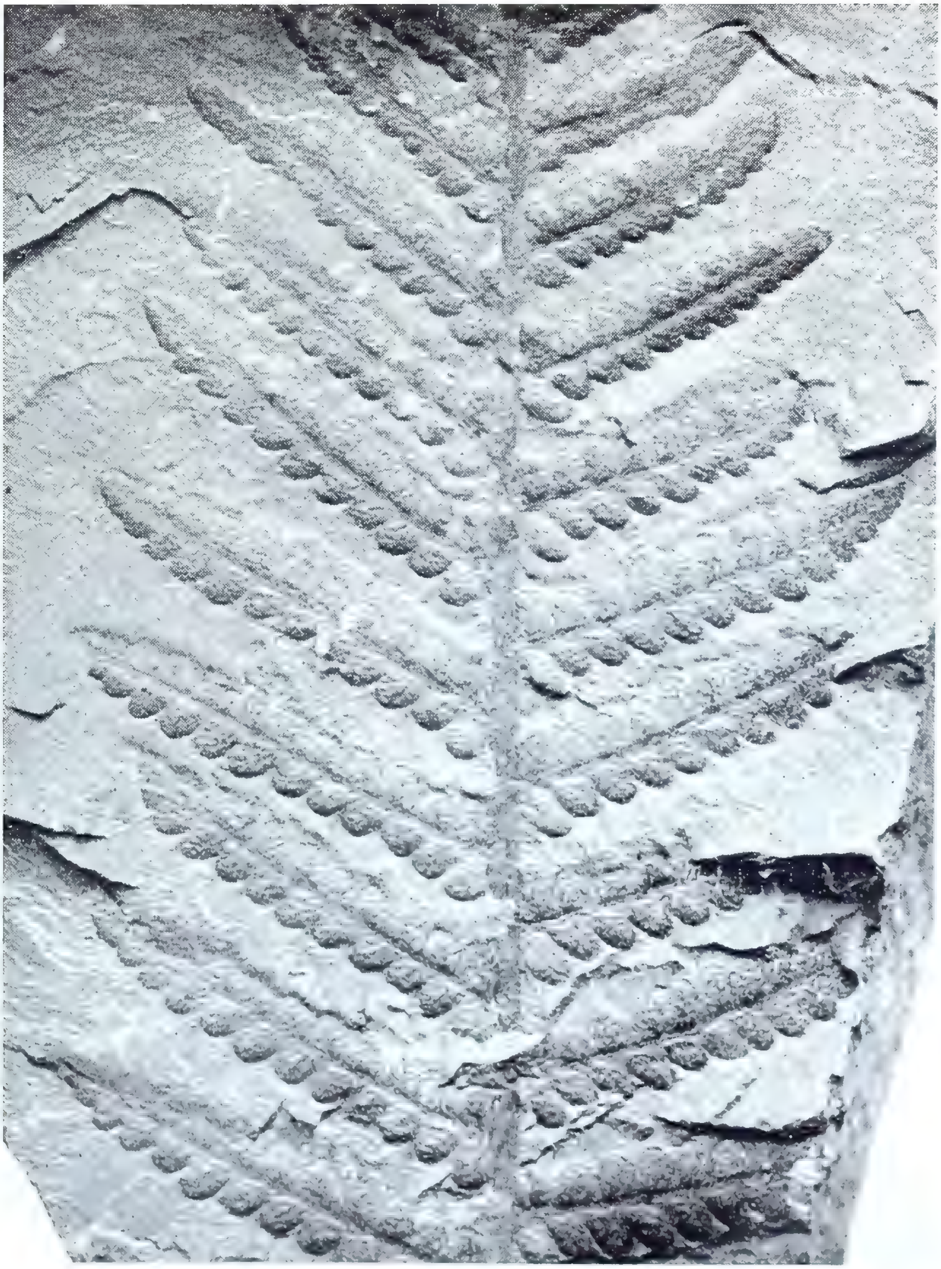


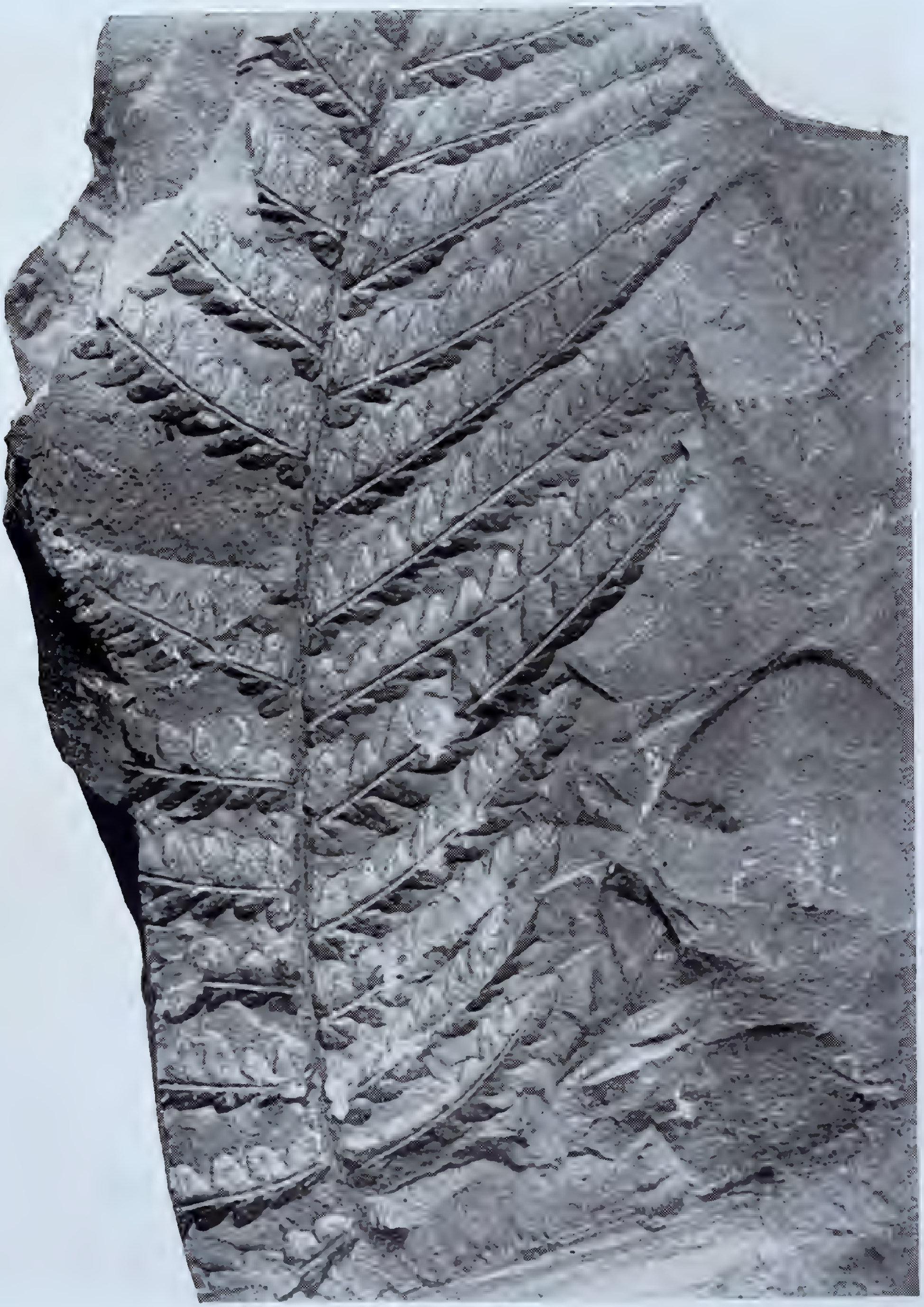


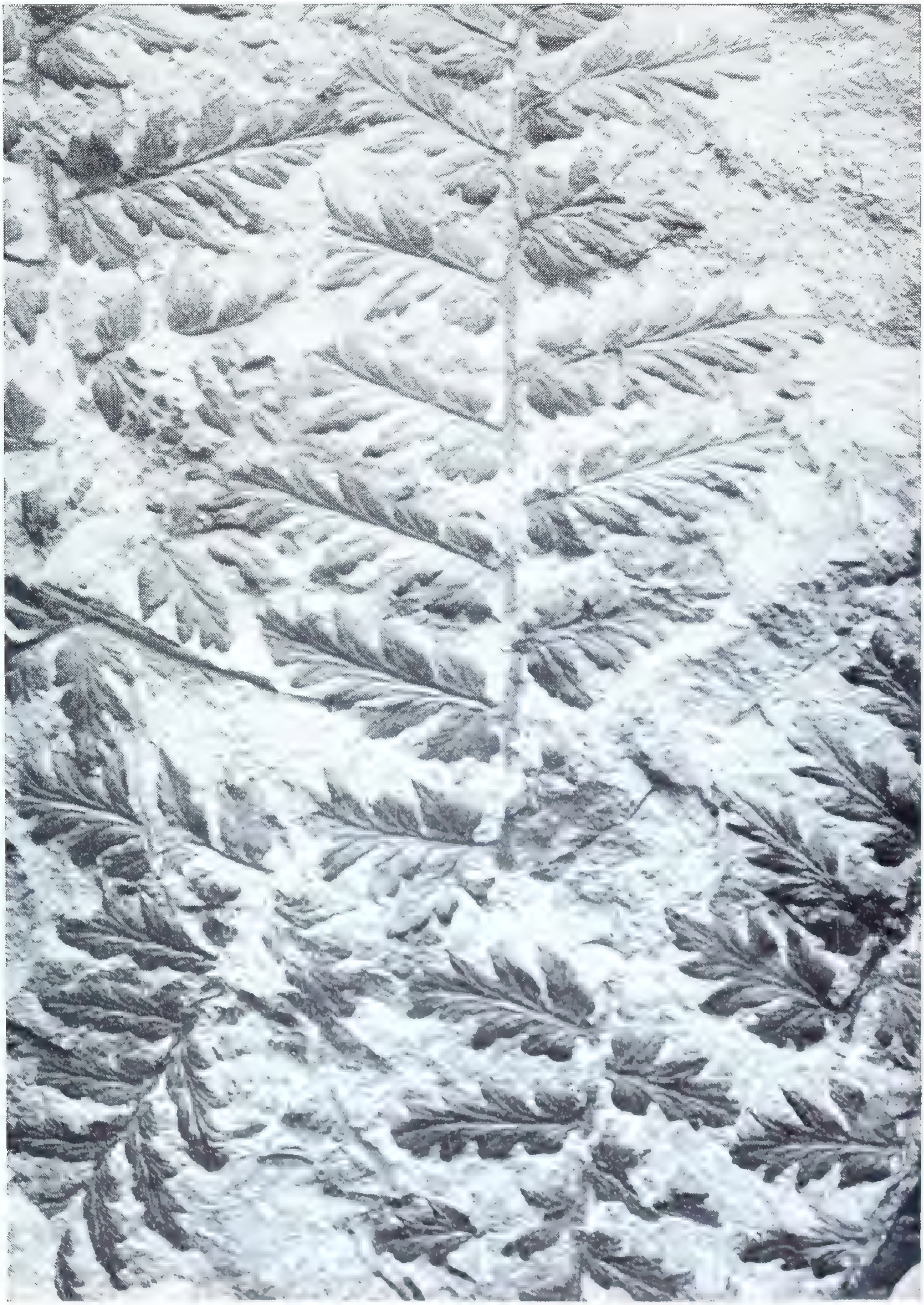


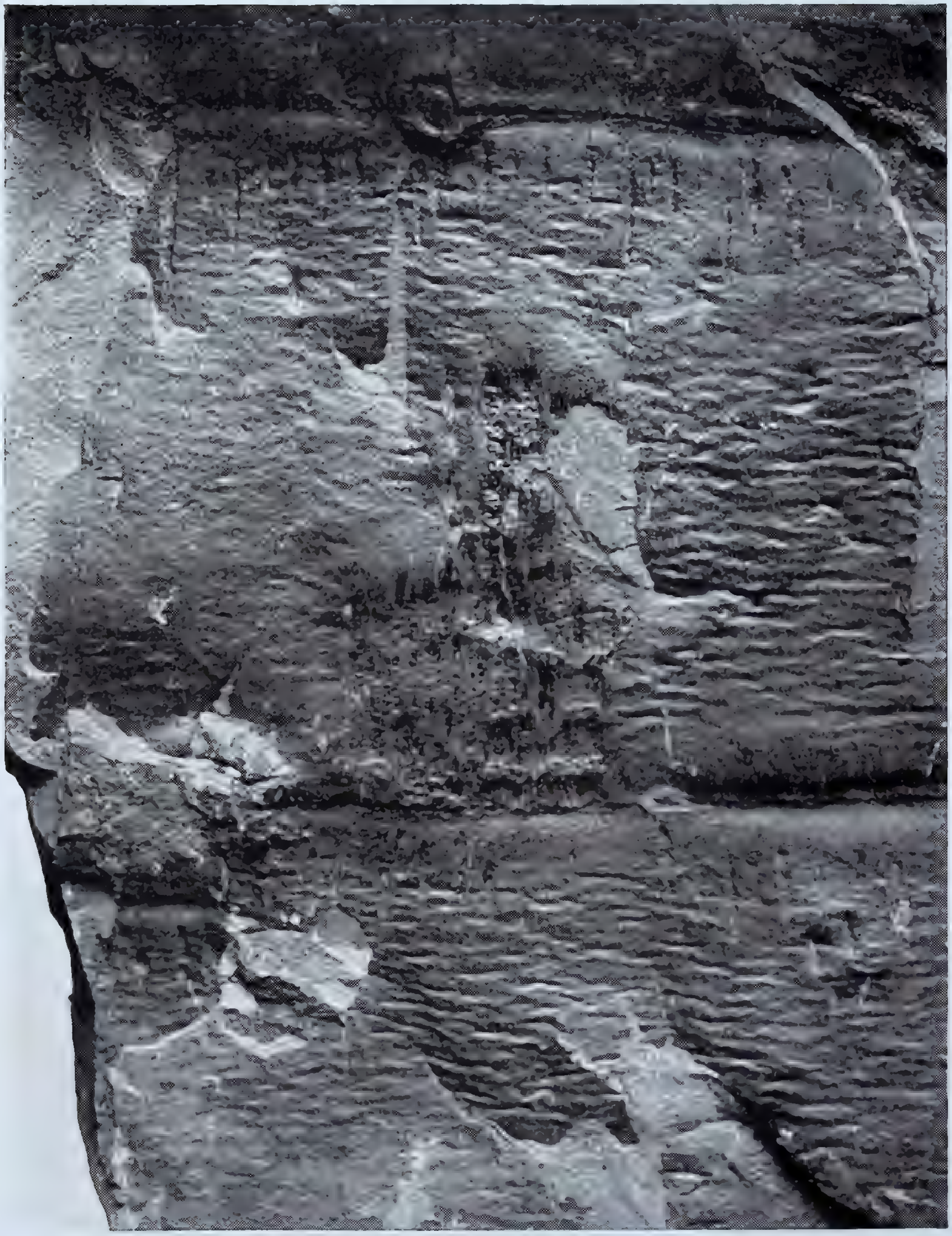


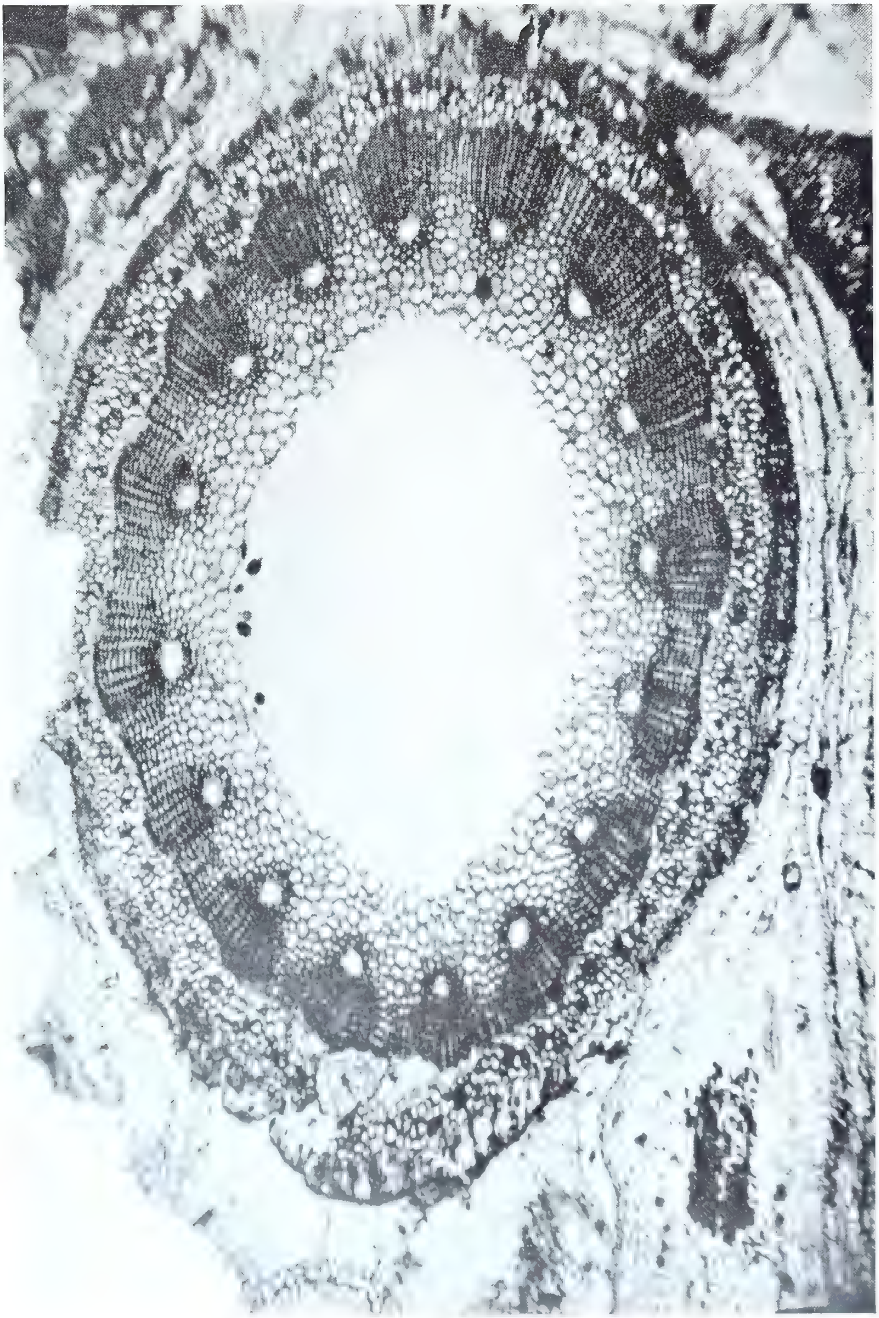


PECOPTERIS PLUMOSA. (ARTIS)



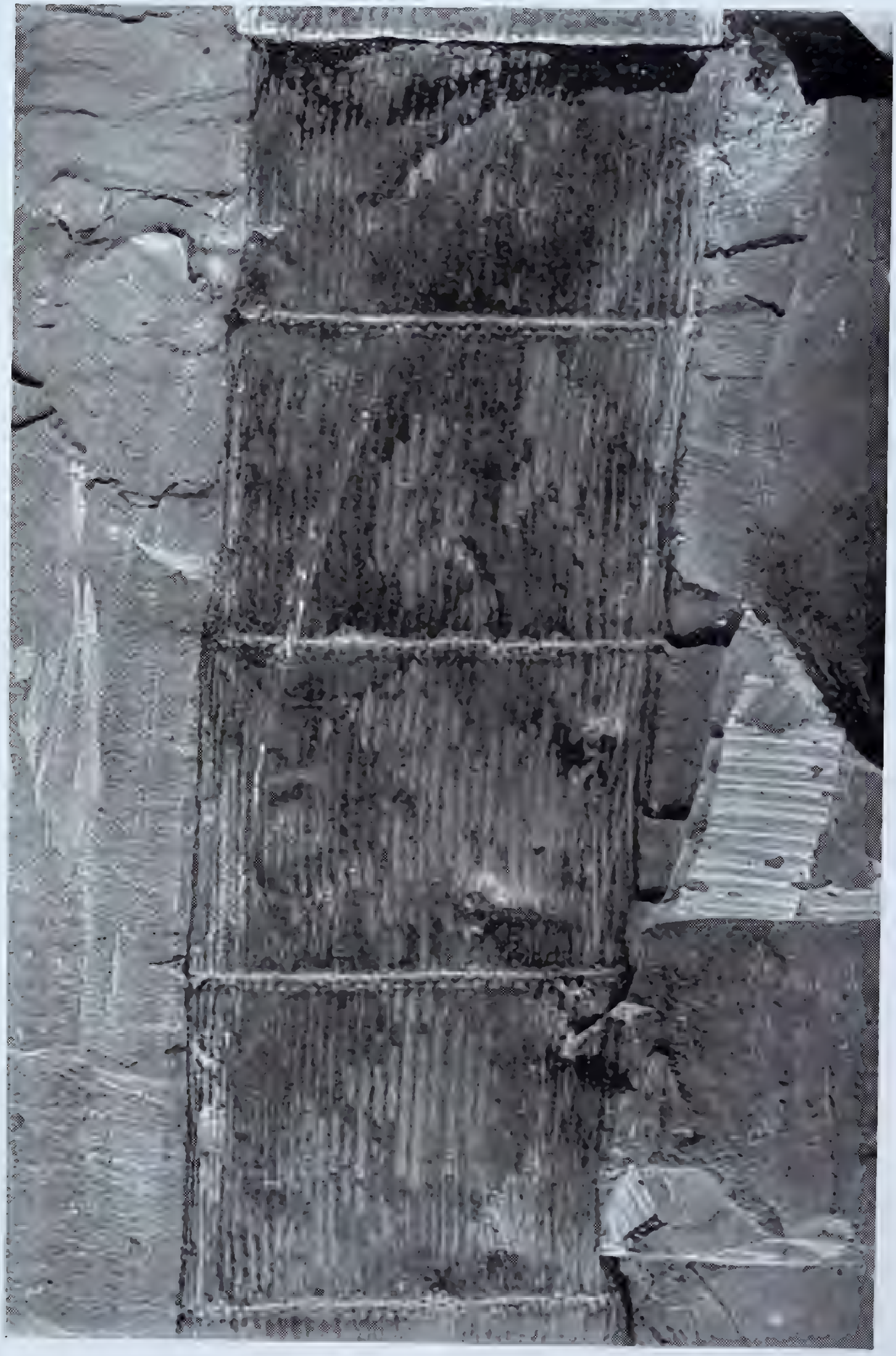


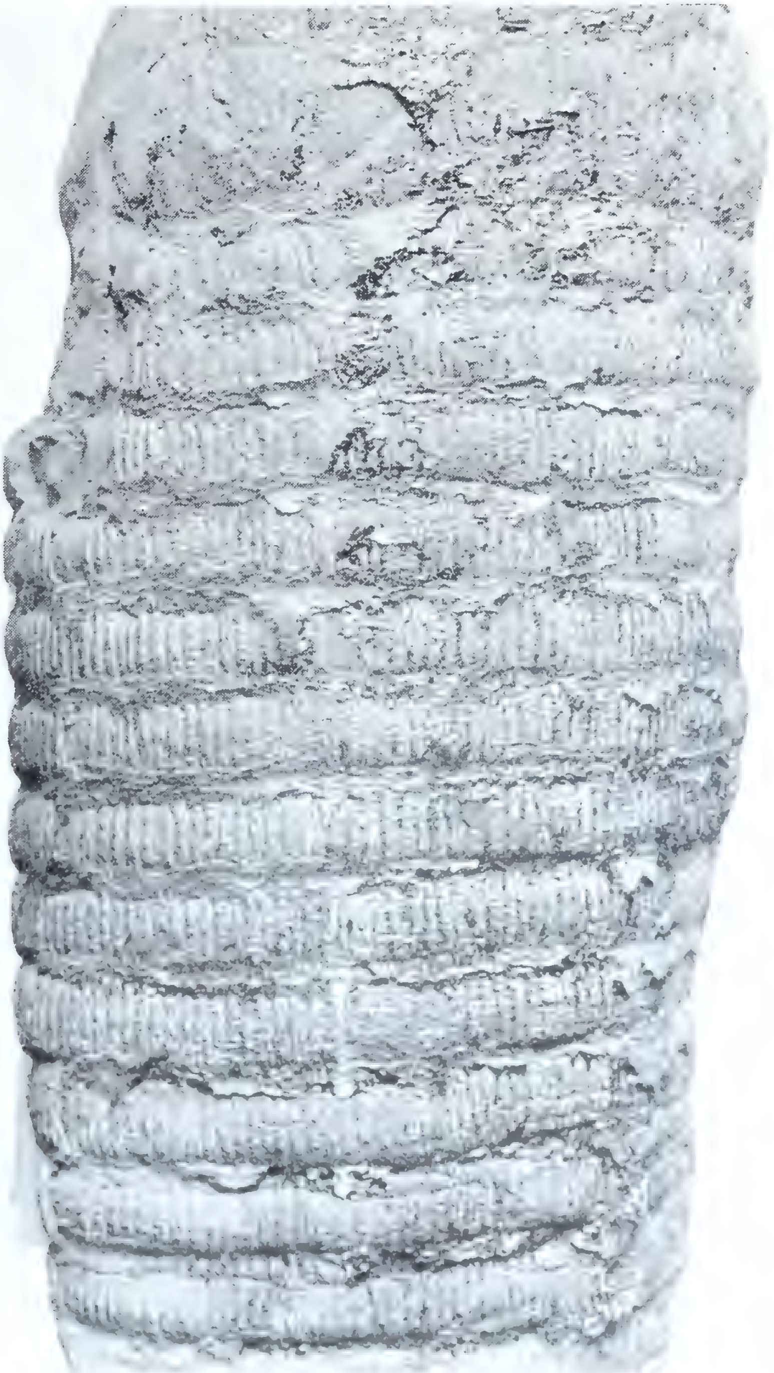




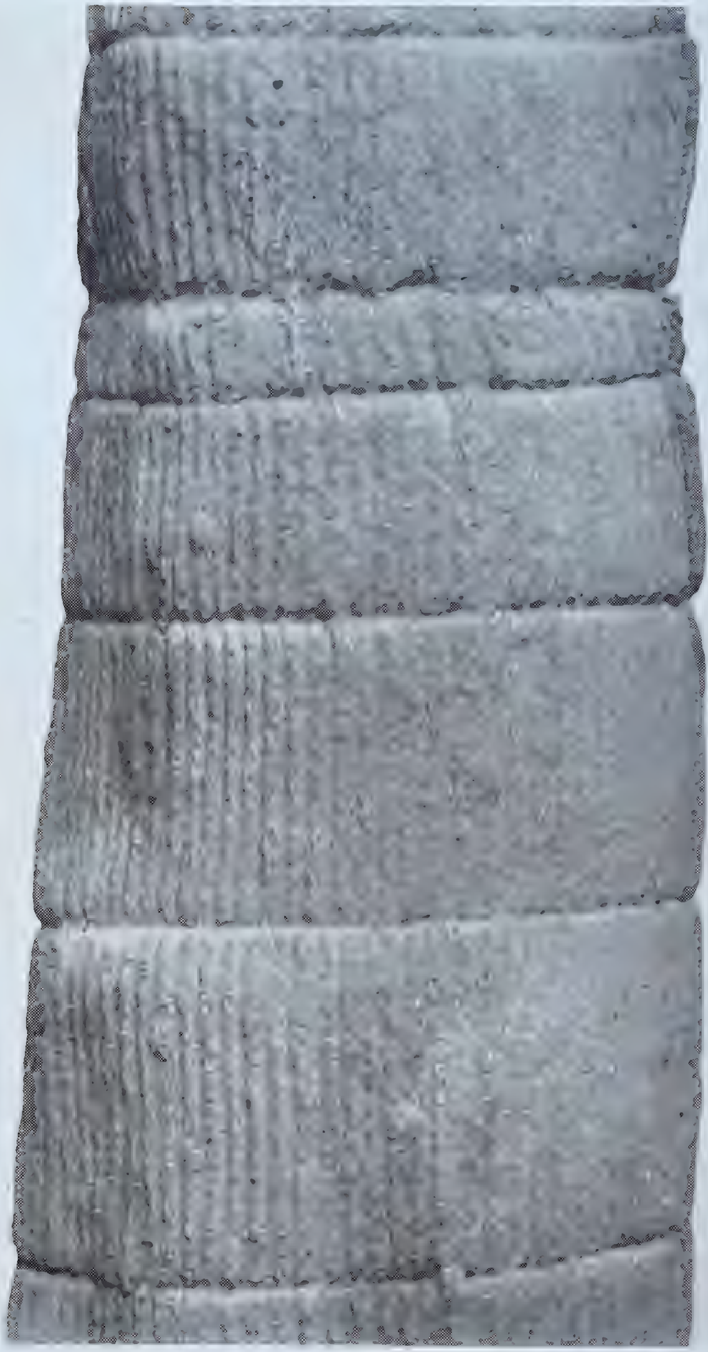
Transverse Section

CALAMITES SUCKOWI. BRONGNIART

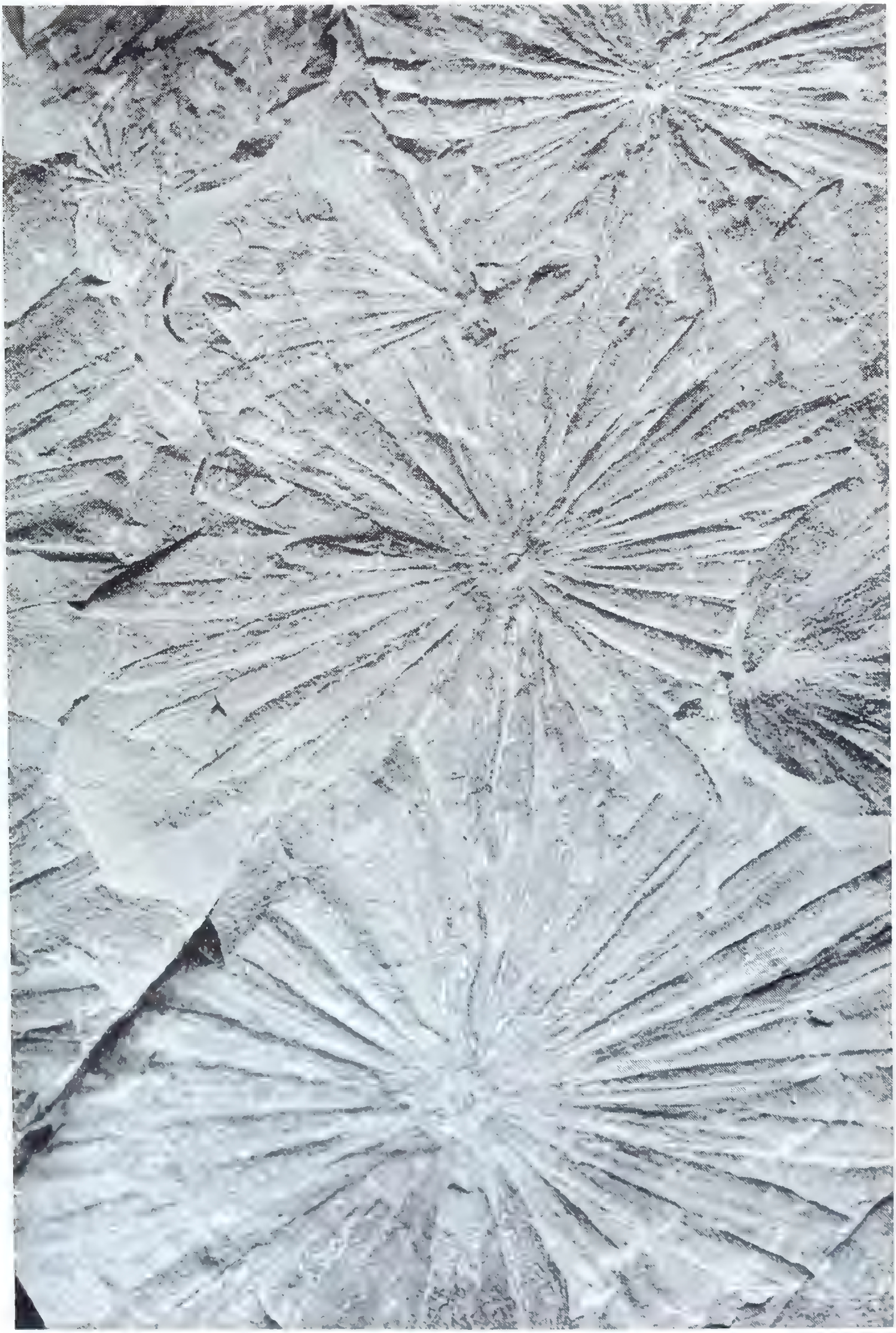




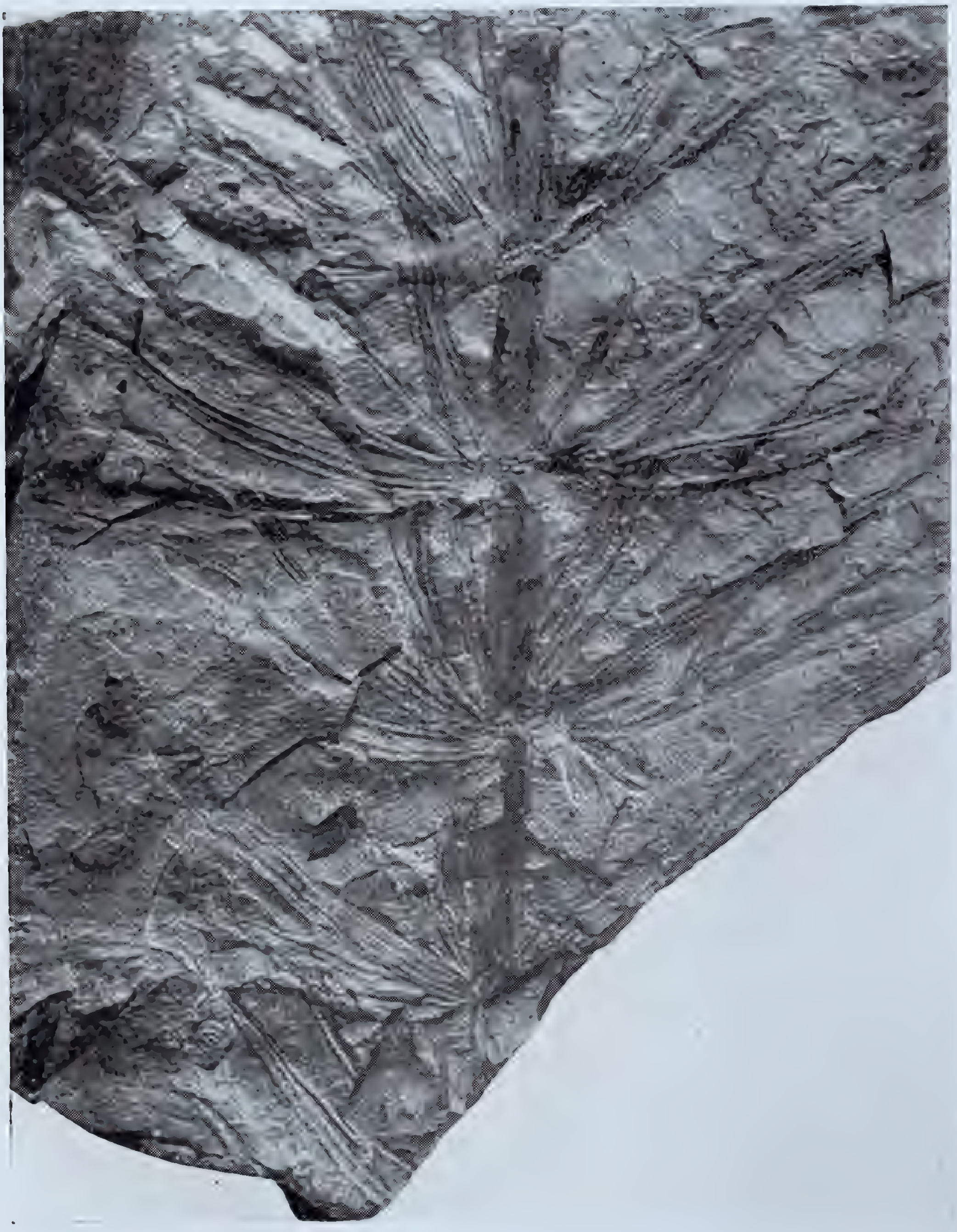
CALAMITES VARIANS. STERNBERG

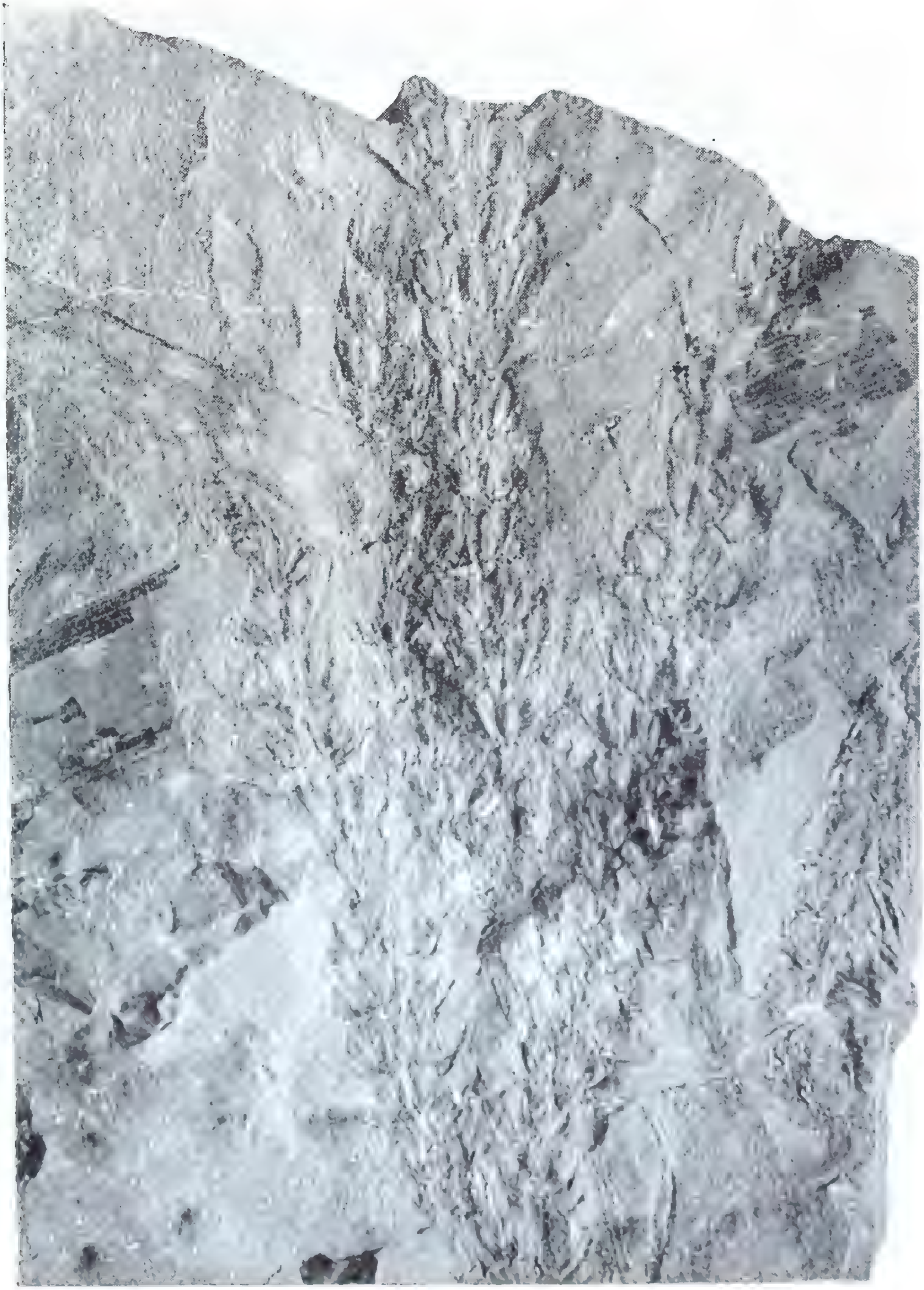


ANNULARIA STELLATA. (SCHLOTHEIM)

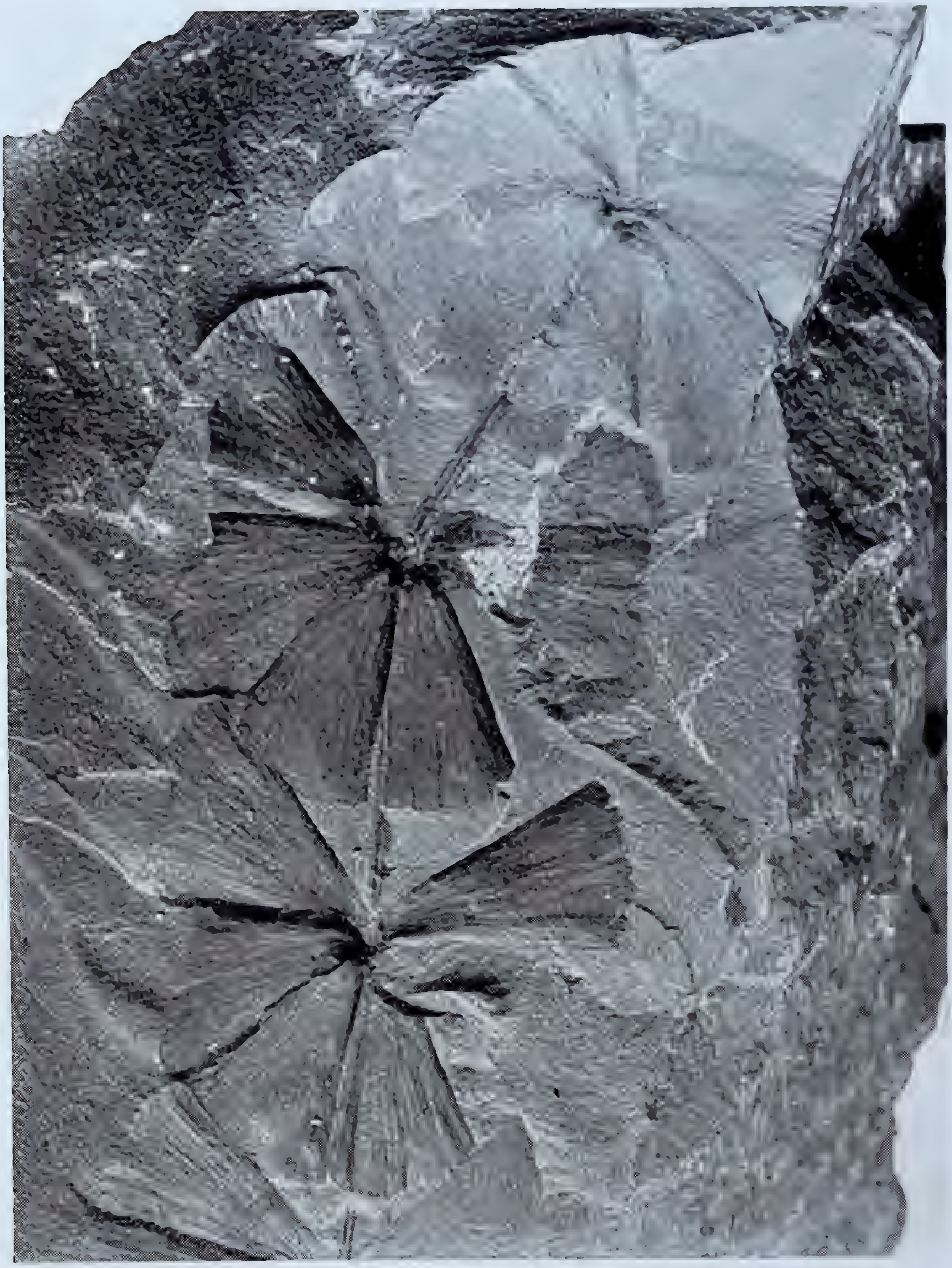


CALAMOCLADUS EQUISETIFORMIS
(SCHLOTHEIM)

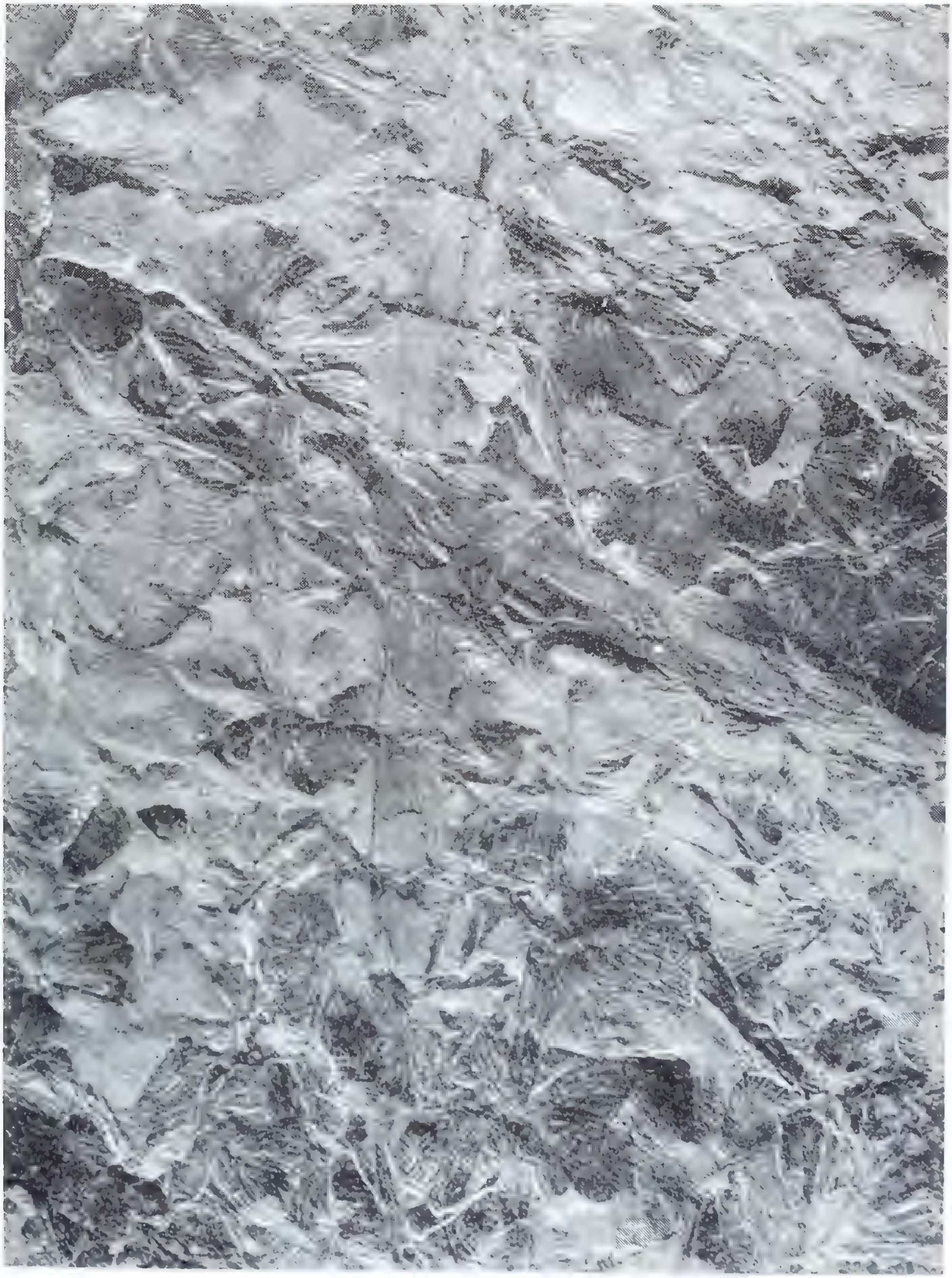




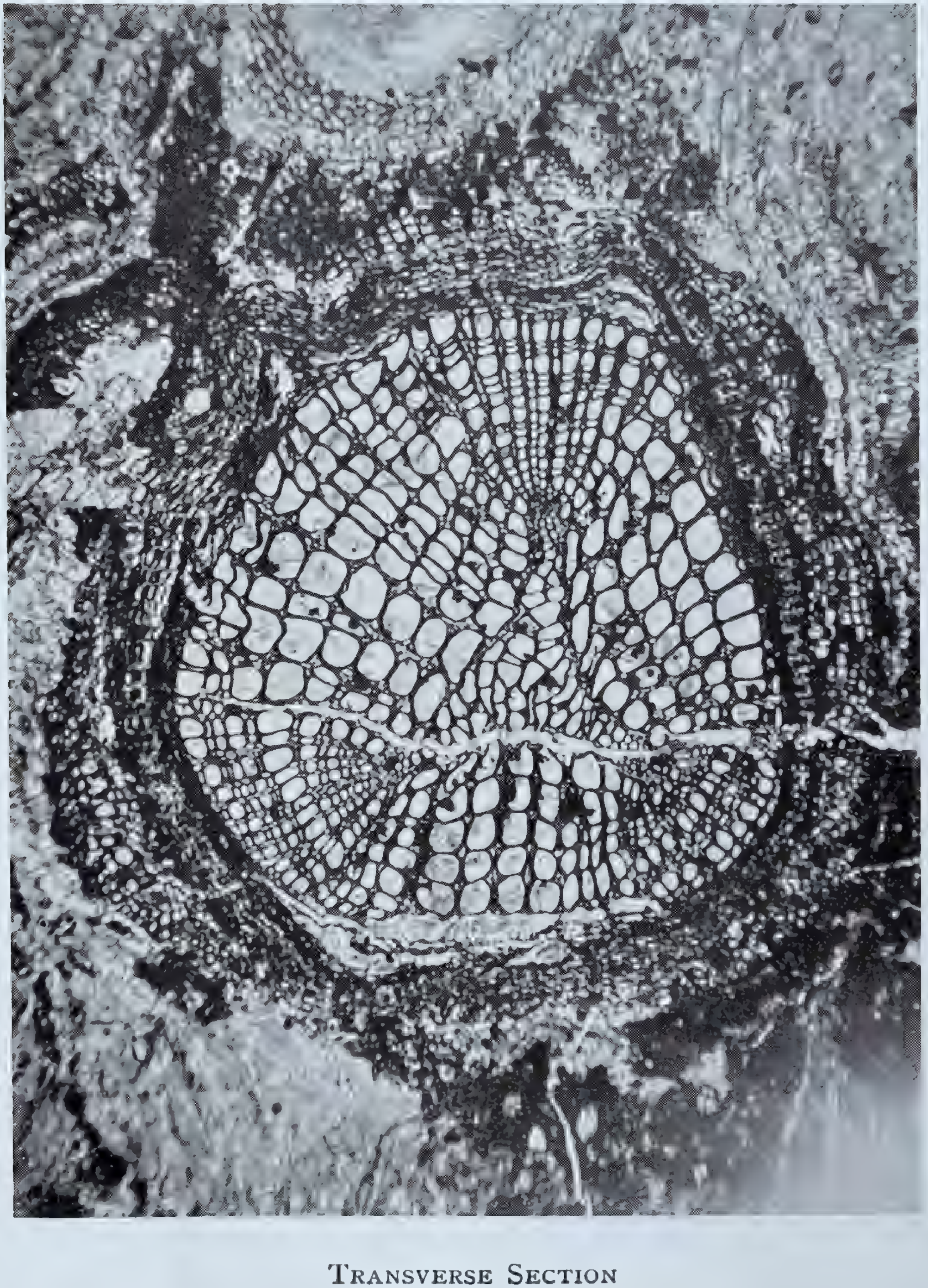
SPHENOPHYLLUM EMARGINATUM BRONGNIART



SPHENOPHYLLUM EMARGINATUM
BRONGNIART

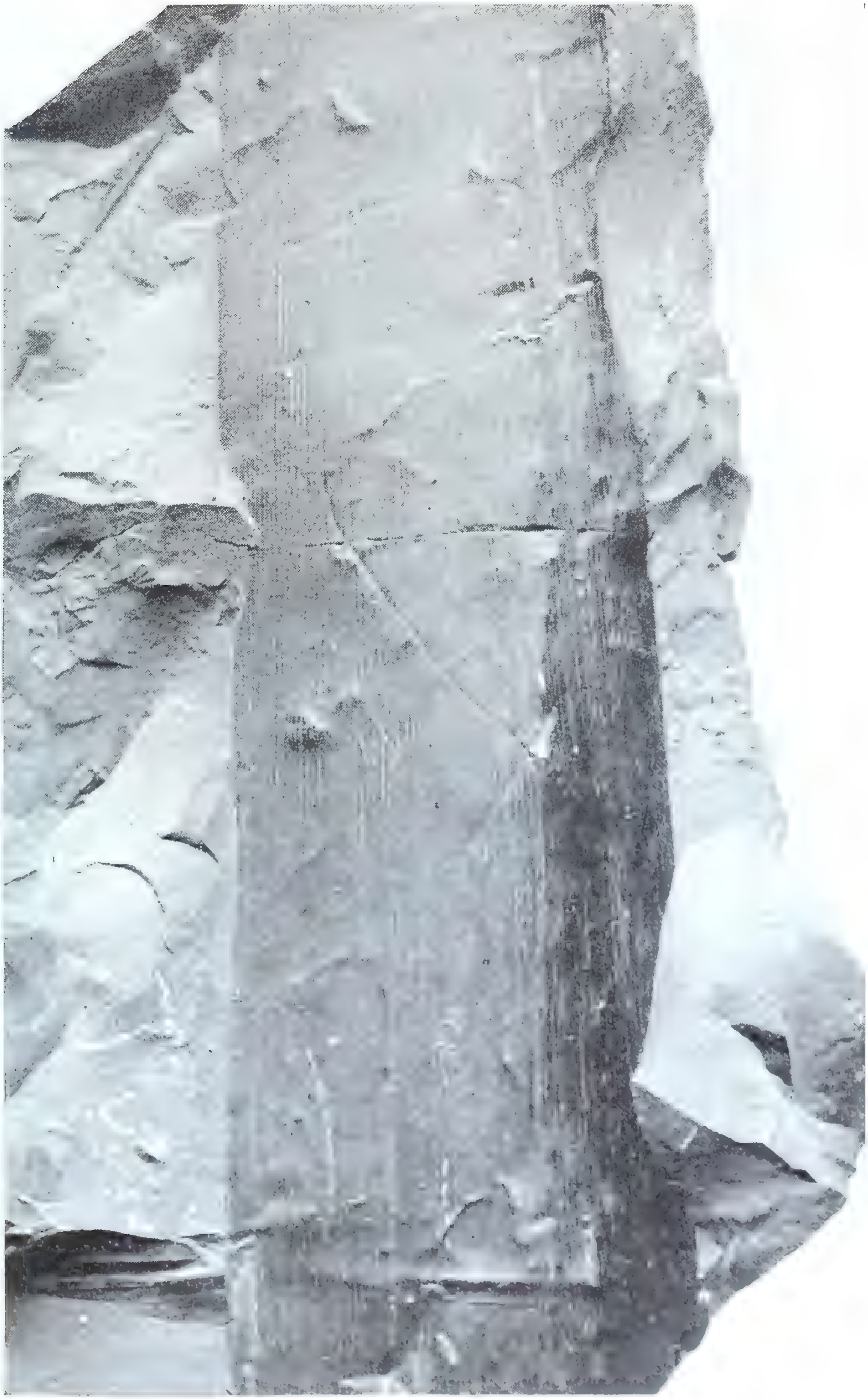


SPHENOPHYLLUM PLURIFOLIATUM WILLIAMSON & SCOTT

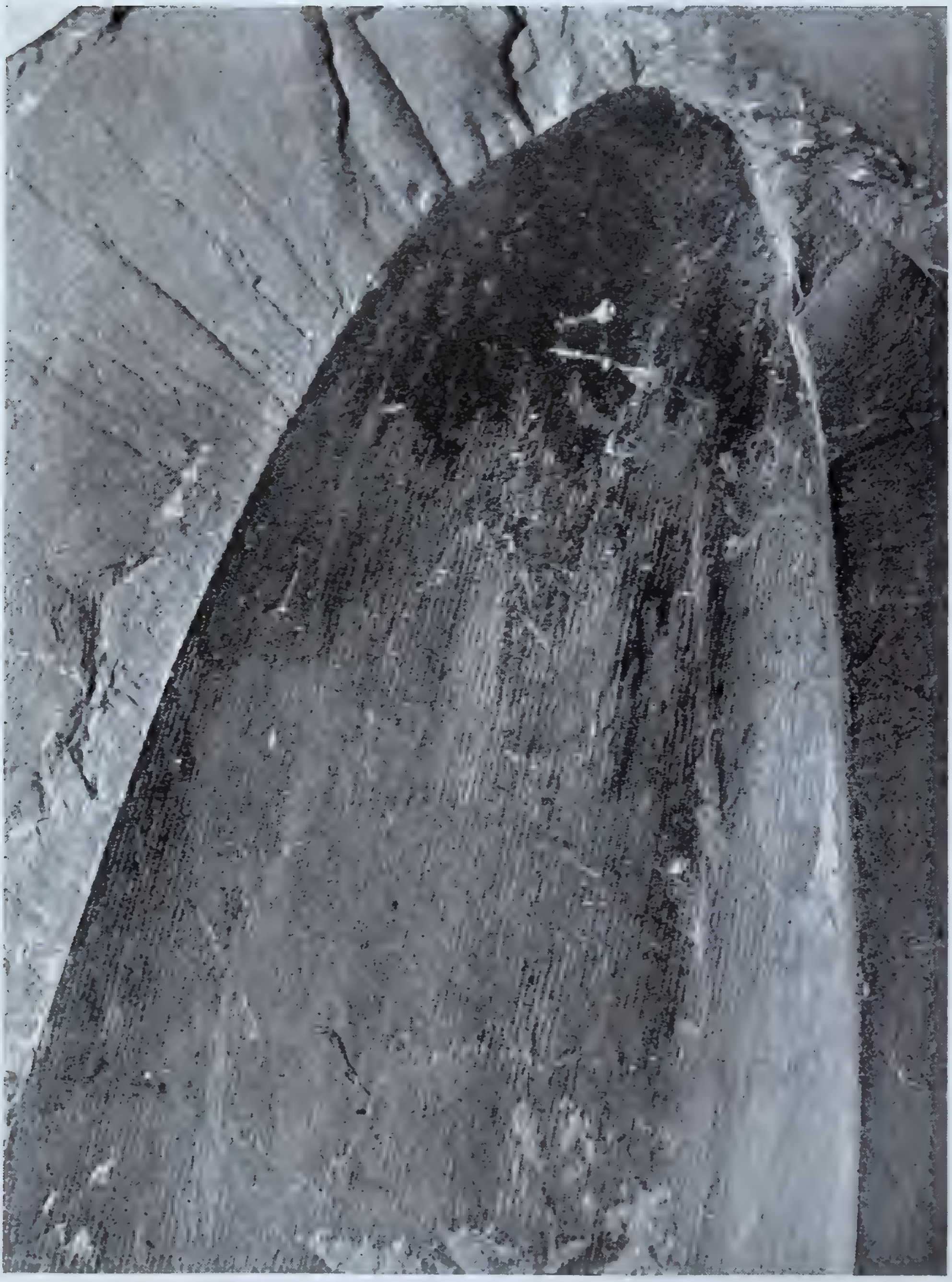


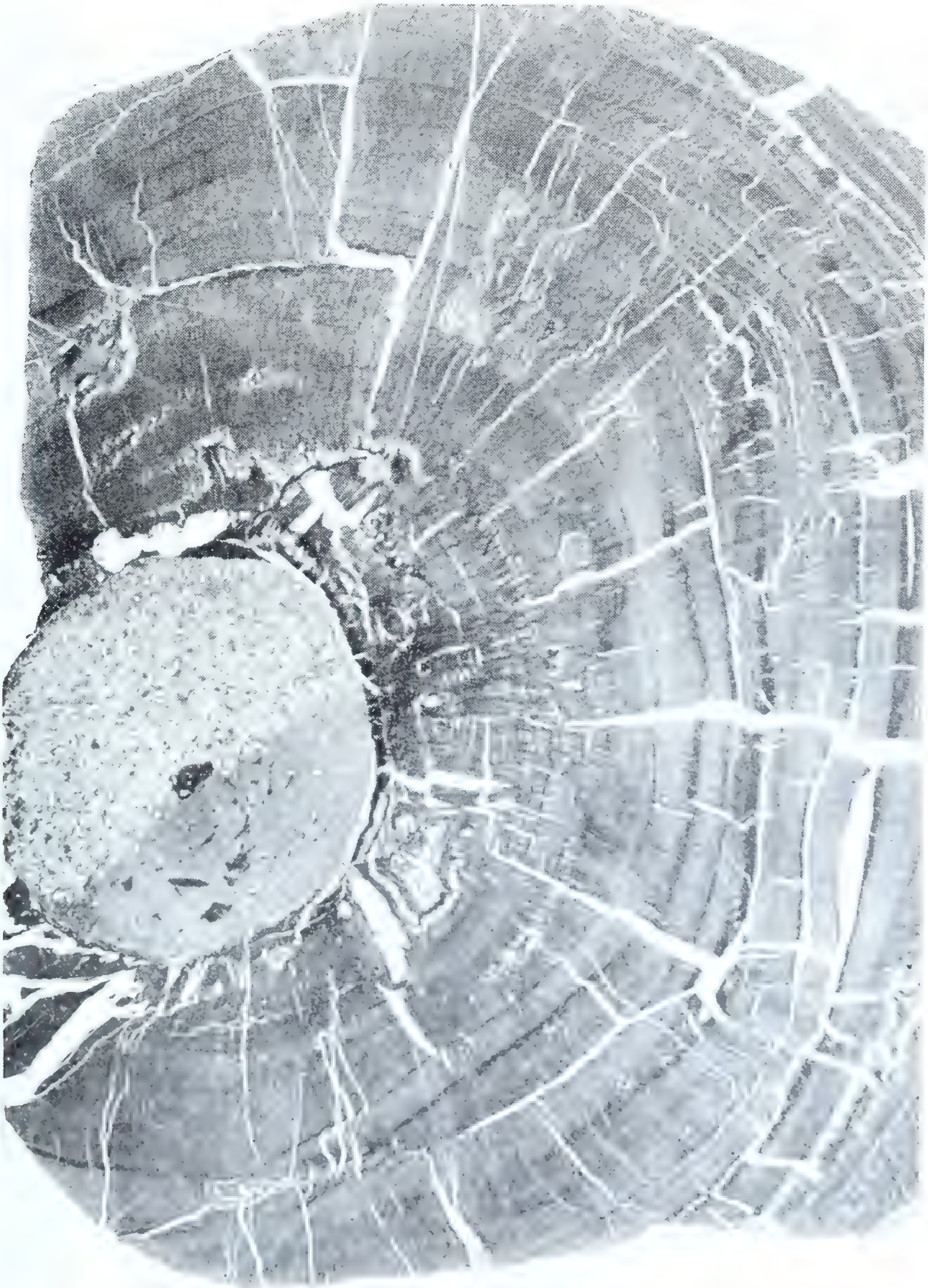
Transverse Section

CORDAITES ANGULOSOSTRIATUS
GRAND'EURY



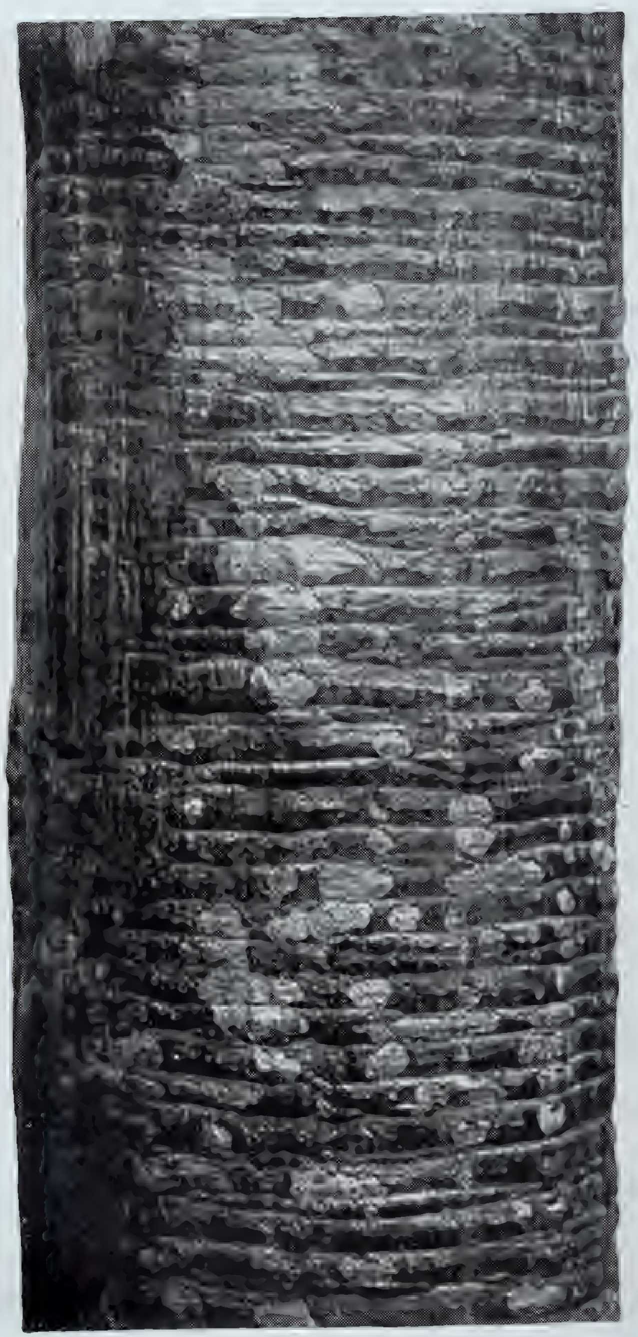
CORDAITES ANGULOSOSTRIATUS
GRAND'EURY





Transverse Section

CORDAITES sp.



Fossil Plants.

NOTES ON THE SPECIMENS

OF WHICH

PHOTOGRAPHS APPEAR ON THE PRECEDING PAGES . .

BY

E. A. NEWELL ARBER, M.A., F.L.S., F.G.S.,

Demonstrator in Palæobotany in the University of Cambridge.

THE fossil plants figured in this little book are all from the very ancient rocks, known to Geologists as the Coal Measures or Upper Carboniferous, which form the great coal-bearing strata in Britain. Most of them are common species to be collected by hammering and splitting the shales and sandstones thrown out of the mines on to the waste heaps of collieries in various parts of this country.

The age of these specimens is inconceivably great. If it could be guessed at, it would amount to millions of years. It is therefore very wonderful that they should be so well preserved.

A word or two about the manner of preservation may not be out of place here. Fossil plants nearly always occur in small fragments—a leaf here, a stem there, and a cone or a seed somewhere else. It is rarely that two parts of the same plant are to be found still united, though not infrequently the leaves are still attached to the stems.

No part of the original substance of the plant remains in any specimen. But replicas of them have been handed down to us, and these have been formed in two quite different ways, as follows:—

Casts and Impressions.—When one of these ancient plants died, one or other part of it, let us say the stem, was washed away by a stream, and became incrusted or covered up in sand or mud. When the sand or mud hardened and became converted into a sandstone or shale, the layer which surrounded the stem in question took an impression of its external features, just as wax takes an impression of a seal, but with this difference, that the impression of the sandstone was the reverse of the stem, prominences becoming hollows and *vice-versa*, whereas with a seal, which is purposely made as a reverse, we get a positive impression on the wax.

Next the stem itself slowly decayed away altogether, or was converted into a very thin layer of coal forming a film over the sandstone or shale impression. When this process was complete an empty space of a size corresponding to that of the stem was left. This space may again have become filled with mud or sand, in which case we get a *cast*, fitting into the impression already made. The features of the cast correspond exactly to those of the original stem.

We may, as a homely illustration, compare such an impression and cast with a mould in which a jelly has been allowed to set. The mould corresponds to the impression, and is the reverse of the original, while the jelly is comparable to a cast. When the mould was manufactured it was fashioned round some hard substance which corresponds to the stem of our plant. An empty mould represents an impression, and the space it encloses, the empty space left when the plant has entirely decayed away. The jelly represents the cast. Most of the photographs reproduced here are from casts or impressions.

Petrifactions.—Casts and impressions are by far the most common type of preservation among fossil plants of all geological ages. They have this peculiarity that, if the surface had not begun to decay before the impression was taken, they show the *external* features. But they never have the internal structure preserved. Often, indeed, especially among stems of *Lepidodendron* and *Sigillaria*, the stems had partially decayed before the impression was made, and thus not the true external surface, but a partially decayed (decorticated) condition is exhibited by such specimens.

In the case of the second type of preservation, the petrifaction, what has happened is altogether different. Let us imagine the stem of a fallen tree permeated and soaked with water highly charged with lime (calcium carbonate) or quartz (silica). As the water percolates through the tree, and the tissues decay cell by cell, the calcium carbonate tends to crystallise out. Each cell as it disappears is replaced by an exactly similar mass of crystaline calcium carbonate or silica, which resembles the original cell in size, shape, and peculiarities—in fact, in all respects. This is what has happened in the case of a petrifaction. A tissue of living cells has been replaced by a precisely similar mass of mineral units. Thus the internal structure is preserved to us, and if we cut thin sections, by carefully grinding down a thin slice of a petrifaction until it is transparent, we can examine them under the microscope, and in many cases they will reveal the internal structure almost as perfectly as a section of a living plant cut by means of a razor. Plates on Pages 11, 12, 26, 30, 51, 60, and 63 are photographs of sections of petrifactions.

Unfortunately, as a rule, petrifactions are of very restricted occurrence. In the British Upper Carboniferous rocks they are only found embedded in calcareous nodules, known as "coal-balls," in one or two seams in the South Lancashire and Yorkshire coalfields.

It may be wondered how it is ascertained that impressions of a certain root and a certain stem belonged originally to plants of the same species, which are found somewhere else preserved as petrifactions. This is the task of the Palæobotanist, and the labours of the last forty years in this direction have made it possible to restore many of the more important Carboniferous plants. This is effected by the correlation in structure of two different organs, or by the discovery of exceptional specimens in which they are still united, or which show both the external features and the internal structure.

The reader, bearing in mind the extreme antiquity of the Carboniferous period, will not, perhaps, be surprised to hear that the flora at that time differed very greatly from the flora of to-day.

At the present day the Dicotyledons and Monocotyledons predominate over all the other groups of the higher plants. These are the plants bearing flowers.

But in Carboniferous times there were five great flowerless groups, all of which are illustrated here. Of these, three, the *Sphenophyllales*, the *Pteridosperms*, and the *Cordaitales*, became totally extinct millions of years ago. The other two, the *Lycopodiales* and the *Equisetales*, have still a few survivors to-day in our Club-mosses and Horsetails, though they are now scanty remnants of what in Carboniferous times were very large and complex groups.

The asterisk (✻) denotes the name of the authority who first described the species.

THE LYCOPODIALES.

Our first group includes the ancient Palæozoic representatives of our Club-mosses. Unlike the present-day survivals of this group, the Carboniferous Lycopods were large trees, often 100 feet or more in height. There are four common genera, the stems of which are known as **Lepidodendron, Lepidophloios, Sigillaria,** and **Bothrodendron,** as well as cones (**Lepidostrobus**) and underground stems or rhizomes (**Stigmaria**).

LEPIDODENDRON.

Page 6. **Lepidodendron sp.** Part of a branch just beginning to fork above. The branch is covered with the persistent bases of the fallen leaves, which give it a characteristic appearance. The leaves were spirally arranged and closely set. When the leaves fell off, their lozenge-shaped bases remained attached to the stem. From the Yorkshire coalfield. $\frac{4}{5}$ natural size.

Page 7. **Lepidophyllum sp.** Detached leaves of a Lepidodendron or an allied genus. The leaves are quite simple. They may be long or short, straight or curved, but are always narrow, and possess only a single nerve, which is clearly seen in the photograph. In this specimen the leaves are long and straight. From the Somerset coalfield. × $\frac{4}{5}$.

Page 8. **Lepidodendron aculeatum, Sternberg.*** Part of a stem similar to that shown on page 6, enlarged to show the form of the leaf-bases characteristic of this species. The leaf-bases are separated by sinuous bands of bark. A little above the middle of each leaf-base two scars can be seen, the lower being the actual point of attachment of the leaf itself, known as the leaf scar, the upper and smaller, the triangular scar of the "ligule," which was a small outgrowth from the base of the leaf. Below the leaf-scar, the leaf-base has a marked longitudinal ridge with several small transverse ridges. From the Yorkshire coalfield. × $\frac{5}{4}$.

Page 9. **Lepidodendron lycopodioides, Sternberg.*** Another common species, in which the shape of the leaf-bases is quite distinct from the last. The leaf-scar is small and is situated near the top of the leaf-base. From the Cumberland coalfield. × 2.

Page 10. **Lepidodendron Wortheni, Lesquereux.*** A third species, quite distinct from the preceding in the form and ornamentation of the leaf-bases. From the Somerset coalfield. × 2.

Page 11. A transverse section from a petrified Lepidodendroid stem, showing one type of internal structure. There is no pith. In the centre the primary wood is seen, which is surrounded by an incomplete and uneven ring of secondary wood. The dark ring, still more external, consists of bast and other tissues; next, we have a large area of inner cortex which is only preserved in part, and finally the outer cortex, in places broken away from the rest. The latter shows several radially arranged gaps through which the leaf-traces pass out into the leaves. From the South Lancashire coalfield. × 2. This and other photographs should be examined with a hand-lens.

Page 12. A transverse section of a petrified Lepidodendroid stem showing another type of internal structure, and one common to both *Lepidodendron* and *Lepidophloios*. In the centre there is a pith, and the narrow light-coloured ring surrounding it is the primary wood. More externally a broader, very dark ring of bast and other tissues is conspicuous. Next, the still broader ring of the inner cortex, in which several leaf-traces are to be seen. The middle cortex is not well preserved, an empty space between the inner and the outer cortex marking its position. From the S. Lancashire coalfield. × 2½.

Page 13. **Lepidostrobus.** A cone belonging to *Lepidodendron.* The cones were long and consist of crowded, spirally-arranged sporophylls or leaves bearing sporangia. In this specimen the cone is split almost through the middle, and the axis can be seen in the upper part. At the margin the upturned edges of the sporophylls can be made out. Some of the darker, obliquely-directed markings between the axis and the margins are the sporangia, which were long, and attached one to the upper surface of each sporophyll. From the South Lancashire coalfield. Reduced, ¾ natural size.

LEPIDOPHLOIOS.

Page 14. **Lepidophloios laricinus,** Sternberg.* *Lepidophloios* differs from *Lepidodendron* in the shape of the leaf-bases, which are diamond-shaped and scale-like, overlapping one another. The leaf-scar is also broader than long, and, in older stems like the present specimen, is situated at the bottom of the leaf base. From the Yorkshire coalfield. Natural size.

Page 15. **Halonia.** A branch of a *Lepidophloios* bearing large, spirally-arranged tubercles, which are generally believed to be the broken bases of the stalks of cones of the *Lepidostrobus* type. The leaf-scars between the tubercles are badly preserved in this example. From the Yorkshire coalfield. ⅔ natural size.

BOTHRODENDRON.

Page 16. **Bothrodendron punctatum, Lindley & Hutton.*** The stems of this genus bore widely separated leaves, the bases of which were not enlarged. The oval leaf-scars, the actual points of attachment of the leaves, are small, and the bark between them is ornamented by a network of fine striæ. From the Yorkshire coalfield. × $\frac{3}{2}$.

SIGILLARIA.

The stems of some Sigillarias were ribbed, while others did not possess ribs. These stems are distinguished from those of *Lepidodendron* and *Lepidophloios* by the fact that the leaf-scars are arranged in vertical rows, those of one row alternating in position with the scars of the adjacent rows on either side.

Page 17. **Sigillaria lævigata, Brongniart.*** A typical ribbed Sigillaria, showing the alternation of the pear-shaped leaf-scars. Each leaf-scar bears three marks or prints, the central one, the smallest, being the print of the vascular bundle of the leaf, while the two broader prints, one on each side of the central print, are called the parichnos. These three prints can also be seen on well-preserved leaf-scars in the three genera already discussed. Notice that the bark between the leaf-scars on the four ribs seen in the photograph is nearly smooth in this species. From the Yorkshire coalfield. × $\frac{5}{4}$.

Page 18. **Sigillaria scutellata, Brongniart.*** Another common species. Compare the shape of the leaf-scar with the preceding, and notice the ornamentation on the ribs between the leaf-scars. From the Newcastle coalfield. Slightly enlarged.

Page 19. **Sigillaria tessellata, Brongniart.*** In many ribbed Sigillarias the leaf scars are placed close together, as in this common species. The form of the leaf scar here is hexagonal, and each leaf scar is separated from its neighbour, above and below, by a transverse groove. Near the bottom of the photograph a number of smaller, narrower, oval scars, crowded together, can be seen. These are the points of attachment of the cones, the reproductive organs. From the South Lancashire coalfield. Slightly reduced.

Page 20. **Sigillaria mamillaris, Brongniart.*** A ribbed Sigillaria, in which the leaf scars are not very distant from one another. The shape of the scar is quite different from that of *S. tessellata*. A large number of cone-scars, like those seen in the last photograph, are conspicuous. From the Yorkshire coalfield. $\frac{5}{6}$ natural size.

Page 21. **Sigillaria discophora (König).*** An example of a Sigillaria in which the stems are not ribbed, and the leaf-scars are placed close together and separated by curved bands of bark. From the Yorkshire coalfield. Slightly enlarged.

Page 22. The Ulodendron state of **Sigillaria discophora (König).** Some stems of this species bear two rows of very large, oval scars, one row on each side of the stem. These have been regarded as the points of attachment of cones, but their real nature is at present doubtful. Two of these large scars are seen, and between them the leaf-scars, which, however, are not well preserved. From the Yorkshire coalfield. $\frac{3}{4}$ natural size.

Page 23. **Sigillaria camptotœnia (Wood).*** An example of a non-ribbed Sigillaria with distant leaf-scars, separated by broad areas of ornamented bark. The shape of the leaf-scar is characteristic. From the South Wales coalfield. Slightly enlarged.

STIGMARIA.

The underground stems of *Lepidodendron*, *Sigillaria*, and other Palæozoic Lycopods, are almost precisely similar, and are termed *Stigmaria*. *Stigmaria* is the commonest of all Carboniferous fossils, especially in the under-clays beneath the coal seams.

Plate 24. **Stigmaria ficoides (Sternberg).*** A sandstone cast of one of the main branches of the underground stem. It bears many oval scars, to which the rootlets or Stigmarian appendages were attached. Natural size.

Plate 25. Stigmaria ficoides (Sternberg). On the left hand side, part of an underground stem with its oval scars like that on page 24 is seen, to which several rootlets, running out to the right, are still attached. From the Newcastle coalfield. Slightly reduced.

Plate 26. Transverse sections of petrified specimens of *Stigmaria.* The section below is from an underground stem. There is a large central pith, the tissue of which is not preserved, and then a broad ring of wood, which is characteristically divided up into bundles. On the outside, on the right of the section, part of the bark or periderm is seen, as a dark band.

The section above cuts across two rows of Stigmarian rootlets or appendages, which have a characteristic appearance. Near the centre of each a small circular patch of tissue is seen, which includes the wood and inner cortex. On the outside there is a large ring, the outer cortex, and between the inner patch and the outer ring a white space, which represents the middle cortex, the tissues of which are not preserved. From the S. Lancashire coalfield. × $\frac{3}{2}$.

THE PTERIDOSPERMS AND FERNS.

Fern-like fronds or leaves are very common in the Coal Measures, but many of them belonged to plants which bore seeds (Pteridosperms) and were thus not of the same nature as the modern ferns. The fronds are classified according to their shape and nervation, as they nearly always occur detached from the stems and seeds.

SPHENOPTERIS.

The name *Sphenopteris* is applied to fronds, which are much branched (compound) and bear small leaflets, usually much lobed, cut, or divided, and as a rule contracted at the base. The nerves are simple or branched.

Page 27. Sphenopteris Höninghausi, Brongniart.* A very important species, studded with glandular hairs, the prints or scars of which can be seen on the main axis shown in the photograph. The leaflets are small and typical of a *Sphenopteris.* This frond bore seeds (*Lagenostoma*). From the South Durham coalfield. Reduced to $\frac{4}{5}$ natural size.

Page 28. Sphenopteris obtusiloba, Brongniart,* and S. furcata, Brongniart.* The former species, which is one of the commonest, shows the lobed leaflets, contracted at the base, which is characteristic of the Sphenopterids. The latter species, seen near the bottom of the photograph on the right hand side, has more deeply divided and much narrower leaflets. From the Cumberland coalfield. × $\frac{7}{6}$.

Page 29. Sphenopteris neuropteroides (Boulay).* A fourth species in which the lobes of the leaflets are very broad. From the Forest of Dean coalfield. × $\frac{5}{4}$.

Page 30. Transverse section of a petrified stem of Lyginodendron oldhamium (Williamson), which bore the frond Sphenopteris Höninghausi (Page 27). In the centre, a dark patch marks the position of the pith. Outside this is a broad ring of secondary wood. On the inner margin of the secondary wood and the outer margin of the pith, there were five small groups of primary wood, which can just be made out. Outside the ring of secondary wood, a dark, circular patch represents the bast and pericycle, through which several leaf-traces can be seen passing out to the leaves. More externally the inner cortex is preserved in part on the upper side, and on the right hand. The ring of the outer cortex, with its dark bands of thick walled cells, is very characteristic. The anatomy of this stem combines characters partly belonging to the Ferns and partly to Cycads. From the South Lancashire coalfield. × 5.

Page 31. **Sphenopteris (Zeilleria) delicatula** (Sternberg).* A delicate and graceful frond of the Sphenopteris type, with very small, narrow, divided pinnules. The fructification is known as *Zeilleria*. From the Cumberland coalfield. Slightly enlarged.

Page 32. **Sphenopteris (Renaultia) chærophylloides** (Brongniart).* Another species, showing the nervation, the leaflets not being very deeply lobed. The fructification of this frond is known as *Renaultia*. From the Yorkshire coalfield. Slightly enlarged.

NEUROPTERIS.

The fronds known as *Neuropteris* are often much branched, but possess larger leaflets than those of *Sphenopteris*, and are attached at the base by a single point. The leaflets are oval or oval-lanceolate in shape, and possess a central or median nerve, which does not, however, extend to the apex. The lateral nerves usually branch several times.

Page 33. **Neuropteris heterophylla**, Brongniart.* A small part of a frond of a common species, showing the shape of the leaflets, their attachment at the base, and the nervation. This frond bore seeds (*Rhabdocarpus*, page 38). From the Nottinghamshire coalfield. Slightly enlarged.

Page 34. **Neuropteris heterophylla**, Brongniart.* Another frond of the same species, showing simple, lance-shaped leaflets near the apex, which become divided below into oval, heartshaped leaflets. From the Yorkshire coalfield. Reduced $\frac{4}{5}$.

Page 35. **Neuropteris gigantea**, Sternberg.* Another species with very regular, oval leaflets, all nearly similar in size, and with very much branched, fine, lateral nerves. From (?) the South Staffordshire coalfield. Natural size.

Page 36. **Neuropteris flexuosa**, Sternberg.* Part of a frond, showing the terminal leaflet, and the nervation of the leaflets. From the Shrewsbury coalfield. × $\frac{4}{3}$.

Page 37. **Neuropteris Scheuchzeri**, Hoffmann.* Detached leaflets of a species with large fronds composed of long, lance-shaped leaflets, the lateral nerves of which fork many times. The leaflets were covered with short hairs, which can usually be detected by the short striæ on the surface. From the Somerset coalfield. Slightly reduced.

Page 38. **Rhabdocarpus** sp. The seed of a *Medullosa*, bearing fronds of the *Neuropteris* type. The seed has many longitudinal ridges. From the Somerset coalfield. × $\frac{3}{2}$.

Page 39. **Neuropteris (Cyclopteris)** sp. The main axis of the large Neuropterid fronds often bore large leaflets, differing entirely in shape from those of the rest of the frond. In the photograph, an axis is seen bearing on either side a large, fan-shaped leaflet

(Cyclopteris) the nerves of which radiate from the base. From the Yorkshire coalfield. Slightly reduced.

ALETHOPTERIS.

The large compound fronds of Alethopteris have oblong leaflets, which are usually longer than broad, and attached to the axis by their entire base. The base of the leaflet often runs downward to join on to the leaflet below. There is a central or median nerve, which extends to the apex of the leaflet, and lateral nerves are usually given off almost at right angles to the median nerve. They may be simple or forked.

Page 40. **Alethopteris lonchitica** (Schlotheim).* Part of a very common frond, showing the shape of the leaflets, and the nervation. The median nerve lies in a well-marked groove. From the Nottinghamshire coalfield. Slightly enlarged.

Page 41. **Alethopteris Serli** (Brongniart).* Another species differing in the shape of the leaflets, and in the details of the lateral nervation. From the Somerset coalfield. Slightly reduced.

Page 42. **Trigonocarpus sp.** The complete seed of an *Alethopteris*. The seed had a thick, fleshy outer coat, which is well seen in the photograph, forming the broad border of the specimen. The central oval portion, partly white in colour, which extends upwards as a long spout, is an impression of the inner, hard seed coat, enclosing the seed itself. From the Nottinghamshire coalfield. × 2.

Page 43. **Trigonocarpus Parkinsoni**, Brongniart.* Casts of the seed cavity. The outer and inner seed coats and the seed itself, see page 42, have often perished completely, and all that remains is a sandstone cast of the seed cavity. This has three prominent ridges; hence the name *Trigonocarpus*. From the South Lancashire coalfield. Natural size.

PECOPTERIS.

The fronds of *Pecopteris* were large and much branched, the leaflets being undivided, often oblong in shape, and the two margins frequently parallel. They were attached by their whole base to the axis. The apex of the leaflet is usually blunt. There is a well-marked, central or median nerve, from which other lateral, simple or forked nerves spring at a wide angle.

Plate 44. **Pecopteris arborescens** (Schlotheim).* A typical species with very regular, oblong leaflets, rounded at the apex. Each leaflet has a median nerve, with simple, unbranched lateral nerves. From the Somerset coalfield. Slightly reduced.

Plate 45. **Pecopteris oreopteridia** (Schlotheim).* Another species in which the lateral nerves fork. From the Somerset coalfield. Natural size.

Plate 46. **Pecopteris polymorpha**, Brongniart.* In this species many of the lateral nerves fork twice. From the Somerset coalfield. ½ natural size.

Plate 47. **Pecopteris Miltoni** (Artis).* A very common species. From the Somerset coalfield. Slightly enlarged.

Plate 48. **Pecopteris plumosa** (Artis).* In this species the leaflets are triangular and pointed. The fructification (*Dactylotheca*) is known. From the Somerset coalfield. × $\frac{4}{3}$.

MARIOPTERIS.

The fronds of *Mariopteris* are distinguished from those of *Pecopteris* by the fact that the leaflets are often lobed or toothed, and generally contracted at the base, and especially by the nervation. The axis of the frond also forks repeatedly.

Frontispiece—**Mariopteris muricata** (Schlotheim). A very common fossil, and one which, like the fronds of many other Carboniferous plants, is very variable. In this variety most of the leaflets are simple, but a few are lobed. The photograph shows the shape of the leaflets and the characteristic nervation. From the (?) Yorkshire coalfield. Natural size.

Page 49. **Mariopteris muricata** (Schlotheim). Another variety in which the leaflets are narrower and nearly all lobed. From the (?) Yorkshire coalfield. Slightly reduced.

THE EQUISETALES.

The Equisetales, of which our modern Horsetails *(Equisetum)* are now the sole survivors, were a great and important group in Carboniferous times. The Palæozoic *Calamites* were unlike the Horsetails in habit, for the Calamites were large forest trees often of considerable height. In other features however, such as the segmentation of the stem into nodes and internodes, and in the fact that the leaves and branches sprang only from the nodes, a considerable resemblance exists between the ancient and modern representatives of this group.

Page 50. **Calamites Britannicus**, Weiss.* This specimen shows the external surface of the bark of a Calamite, which is very rarely preserved. Two constrictions or nodes are seen, and two internodes. The surface of the internodes is smooth, but ornamented by short grooves, mostly directed transversely. The upper node bears the scar of a branch. No leaves are seen on this specimen. From the Yorkshire coalfield. Slightly reduced.

Page. 51. **Calamites sp.** Transverse section of a petrified stem of a Calamite. As a rule the casts of Calamite stems are pith-casts, which are formed by the filling up of the hollow pith cavity by mud or sand, which, when set hard, gives us a shale or sandstone cast. The next three photographs show such pith-casts. Where, however, the stem is preserved as a petrifaction, the internal anatomy can be studied. This photograph shows a cross section of such a stem. The clear space in the centre is the pith-cast filling the central, hollow portion of the pith. Part of the pith itself is preserved outside this cast, and next we see a ring of dark, wedge-shaped vascular bundles, the wood, each with a large, circular canal at its inner extremity. Between the bundles thin walled medullary rays are seen. Outside the wood the cortex is visible, which externally is strengthened by a thin layer of bark. The whole structure of the stem recalls that of a modern Horsetail. From the Lancashire coalfield. × about 10. (Photomicrograph by Mr. Tams.)

Page 52. **Calamites Suckowi**, Brongniart.* A pith-cast showing five nodes, and portions of six internodes. In this species the internodes are often broader than long, and the nodes do not bear any branch-scars. The internodes are ridged and grooved longitudinally, as is the case in all Calamitean pith-casts. Usually the ridges and grooves of successive internodes alternate. Below each node, and between the ridges of the internode, a ring of small scars may be seen. These are termed the infranodal canals, and their size and shape is made use of in distinguishing between the species of pith-casts. From the Warwickshire coalfield. $\frac{3}{4}$ natural size.

Page 53. **Calamites approximatus**, Brongniart.* Another species of pith-cast with short internodes, and occasionally, as at the top of the photograph, a much longer internode, bearing several branch-scars just above the node. From the Cumberland coalfield. Slightly reduced.

Page 54. **Calamites varians**, Sternberg.* A sandstone pith-cast of a species, the internodes of which vary in length. Branch-scars may occur on a single node, separated by several internodes from the next branch-bearing node, as in the last specimen. From the Yorkshire coalfield. Reduced $\frac{3}{5}$.

Page 55. **Annularia stellata** (Schlotheim).* The leaves of all Calamites were borne in whorls at the nodes of the stems. In the *Annularia* type of leaf-whorl, the leaves are united into a small collar or sheath at the base. The free portions of the radiating leaves are of unequal length. Each leaf has a single nerve, and in this species the leaves are narrowly lance-like in form. Three whorls belonging to three nodes are seen in this photograph. From the Somerset coalfield. × $\frac{3}{2}$.

Page 56. **Calamocladus equisetiformis** (Schlotheim).* The phtograph shows four whorls of leaves still attached to the nodes of a branch. In the *Calamocladus* type of leaf-whorl the leaves are entirely free at the base from each other, they are nearly equal in length and very narrow, needle-like in shape. From the Somerset coalfields × $\frac{4}{8}$.

Page 57. **Calamostachys** (?) **typica**, Schimper.* Several cones, or organs of fructification, of a Calamite. The bracts and sporangia can be distinguished here and there. From the Canonbie coalfield. × $\frac{3}{2}$

THE SPHENOPHYLLALES.

The Sphenophyllales were an important Palæozoic group, which to-day is quite extinct. The stems were very slender and herbaceous, and were segmented, like those of the Calamite, into nodes and internodes. The nodes were swollen, and the internodes bore longitudinal ridges separated by grooves. The leaves were characteristically wedge-shaped, hence the name *Sphenophyllum*. They were borne in whorls of six, or some multiple of three, at the nodes.

Page 58. **Sphenophyllum emarginatum**, Brongniart.* A slender stem, bearing three whorls, each of six wedge-shaped leaves. The broad apex of the leaf is toothed. A nerve runs to each tooth, and all the nerves unite at the base of the leaf. From the Somerset coalfield. × $\frac{3}{2}$

Page 59. **Sphenophyllum emarginatum**, Brongniart.* In the centre of the photograph a stem is seen. This is the external surface, and the nodes and internodes are clearly marked. The nodes are somewhat swollen. Other fragments of stems, and numerous leaf-whorls and leaves, are scattered over the specimen. From the Somerset coalfield. Slightly enlarged.

Page 60. **Sphenophyllum plurifoliatum,** Williamson & Scott.* Transverse section of a petrified stem. The structure of the stem of *Sphenophyllum* is of great interest from the fact that it resembles closely that of the root of many other plants. There is no pith, and consequently no pith-casts. The central tissue is the wood. The triangular, small-celled, inner portion of the wood is the primary wood, which consists of three radiating arms, the small-celled, first formed elements being at the extremities of the arms. The secondary wood forms a broad zone of large celled, radially-arranged elements, external to the primary wood. More externally still the ring of bark is seen. From the Lancashire coalfield. × about 20. (Photomicrograph by Mr. Tams.)

CORDAITALES.

Our last great group, the Cordaitales, were large trees, in many respects allied to our modern Pines and Firs, though very different from them in appearance. The stems of *Cordaites* were tall and much branched, and the leaves were usually long and strap-shaped, with a characteristic parallel nervation.

Page 61. **Cordaites angulosostriatus,** Grand 'Eury.* Part of a leaf showing the shape and parallel nervation. From the Somerset coalfield. Slightly reduced.

Page 62. **Cordaites angulosostriatus,** Grand 'Eury.* The tip of a leaf, slightly enlarged to show the numerous parallel nerves. From the Somerset coalfield. × $\frac{9}{8}$.

Page 63. **Cordaites sp.** A transverse section of a petrified stem of *Cordaites*, showing a pith internally and a large ring of wood. The structure of the wood is much like that of a Pine. The pith was hollow, but is here filled with a cast of sandstone. From the South Lancashire coalfield. $\frac{1}{2}$ Natural size.

Page 64. **Cordaites sp.** A pith-cast in sandstone. These pith-casts, formerly termed *Artisia* or *Sternbergia*, have numerous constrictions at very short intervals. This is due to the fact that the hollow pith-cavity, in the living state, was bridged at short intervals by diaphragms of tissue, much like the pith of a branch of the Walnut tree. From the South Lancashire coalfield. Natural size.

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